AUTOMOBILE ENGINEER

DESIGN · PRODUCTION · MATERIALS

Vol. 45 No. 1 **JANUARY 1955** PRICE: 3s. 6d.

FBC SEALED BEARINGS

A manufacturer can save money and reputation with FBC sealed bearings :

1 In design; they give you greater compactness; you don't have to allow room for a separate seal. The bearing is exactly interchangeable with the ordinary standard bearing.

2 In machining; you don't have to machine a place for a seal, or provide a polished surface for the seal to ride upon.

3 In safety; this seal cannot form stress-raising scratches in your shafts.

4 The sealing ring is unaffected by ordinary lubricants, being of synthetic rubber. Seal can be on one or both sides.

5 You don't have to rely on some unknown user to lubricate the bearing.

FBC
ALL-BRITISH

F.B.C. : : FISCHER

Ball and parallel-roller bearings

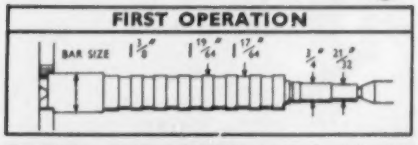
FISCHER BEARINGS COMPANY LIMITED, WOLVERHAMPTON

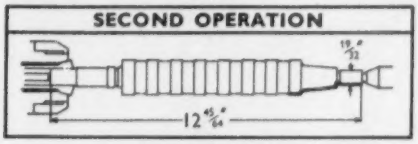
WHEN HIGH PERFORMANCE COUNTS YOU CAN RELY ON **MINTEX**

MINTEX BRAKE AND CLUTCH LINERS ARE MANUFACTURED BY BRITISH BELTING AND ASBESTOS LTD., CLECKHEATON, YORKSHIRE. ALL MINTEX PRODUCTS ARE OBTAINABLE FROM MINTEX SERVICE DEPOTS AND STOCKISTS THROUGHOUT GREAT BRITAIN AND THE WORLD. B.B.A ARE ALSO THE MANUFACTURERS OF 'SCANDURA' THE ORIGINAL P.V.C. FIREPROOF CONVEYOR BELTING.

DUBIED TYPE 514
Rapid Copying Lathes

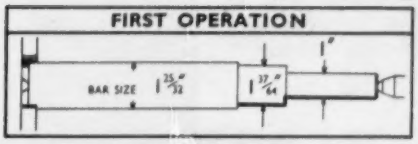
Slash production times...

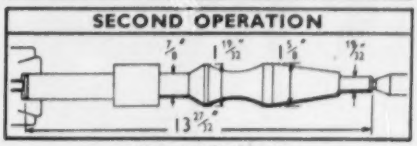




Material St 60. 11
First operation 138 secs.
Second operation 67 secs.
Total time
3 minutes 25 seconds

These lathes copy direct from a workpiece or from a 1:1 templet. Hydraulic power is applied to the feed and rapid return of the longitudinal slide. Parts with shoulders of 90°, tapers, concave or convex forms, etc., are produced in very fast times to a high degree of accuracy and with fine finish. Height of centres 4 11/16". Available with distance between centres 15¾" or 25⅝".





Material St 50. 11
First operation 137 secs.
Second operation 251 secs.
Total time
6 minutes 28 seconds

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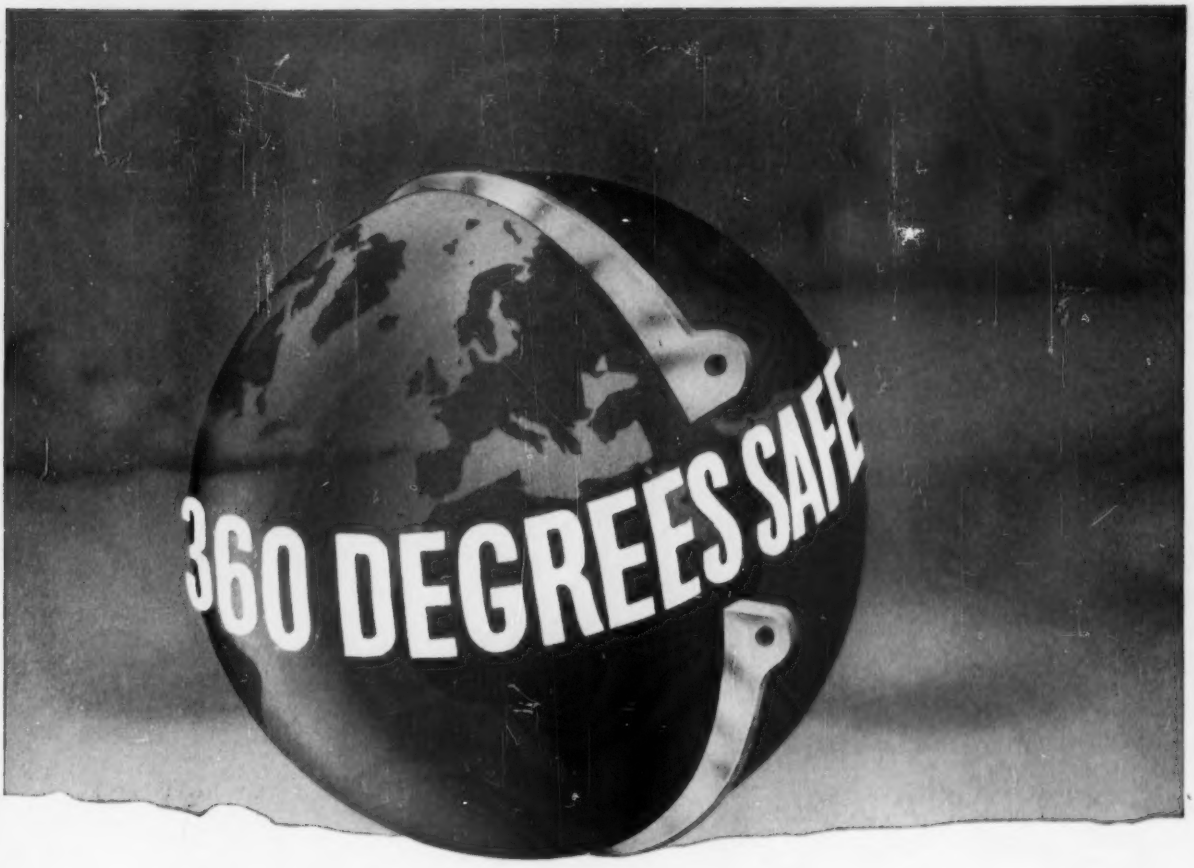

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The Seeger Circlip is a scientifically designed, accurately made engineering component. The design is such that, when sprung into its groove, it is truly circular, so giving uniform pressure all round its periphery.

Discerning designers and engineers will recognise promptly the many applications where the Seeger Circlip replaces—more efficiently and more economically—the old-fashioned locating and retaining methods.

Seeger Circlips eliminate the need for many parts used to locate components on shafts and within sleeves or housings.

They thus cheapen manufacture, facilitate storage and records, lower material cost and substantially reduce assembly times. Finally they produce a strong, efficient and workmanlike assembly.

The "Snarler" is Seeger-Safe

The new Armstrong Siddeley "Snarler" rocket motor is fitted with Seeger Circlips.

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ON THE SUPERCHARGED

ROLLS-ROYCE

SERIES 114

The above illustration shows the Rolls-Royce C.6. S.F.L. Series 114 6-cylinder supercharged power unit, fitted with the Rockford clutch and bell-housing.

The Rockford clutch, with its centrifugally-balanced and effective toggle-action, gives a smooth engagement without imposing any running thrust either when engaged or disengaged.

British made, to a range of types by Borg & Beck Company Limited, Learnington Spa, England.

ROCKFORD

POWER TAKE-OFFS & CLUTCHES

The tangential drive

This very successful feature of the Borg & Beck clutches fitted with the strap drive has a number of practical advantages.

The four pairs of tangential spring steel straps are so arranged that they deflect when the clutch is released, without in any way disturbing the concentricity of the pressure plate. This movement therefore takes place without any metal-to-metal rubbing contact or friction of any kind, and without wear, backlash or noise. Furthermore, accurate balance is retained throughout the full travel.

These clutches embody many of the other well-known Borg & Beck features, including knife-edge bearings to levers and the use of many low stressed low rate pressure springs.

The openings in the housing render the clutch adequately self-ventilating. In addition, the location on the flat-faced flywheel by two locating dowels and eight set-screws obviates the need for a register on the outside diameter of the housing.

BORG & BECK CLUTCHES

B-G-D. TRADE MARK

BORG & BECK COMPANY LIMITED, LEAMINGTON SPA, ENGLAND

PATENTED

BALL SUSPENSION

Thompson suspension ball joints, the result of long research and experiment, have the following outstanding advantages:—

1 By aligning the link articulation centres with the steering swivel, they permit a further separation of the wishbone pivots on the frame. This provides greater width for engine and accessories without robbing the steering lock.

2 They simplify design and the machining of suspension parts because they are self-aligning.

3 They reduce lubrication points to four only (eliminating up to ten points).

4 Servicing of the front suspension is simplified, and a Thompson joint may be changed without dismantling the complete suspension.

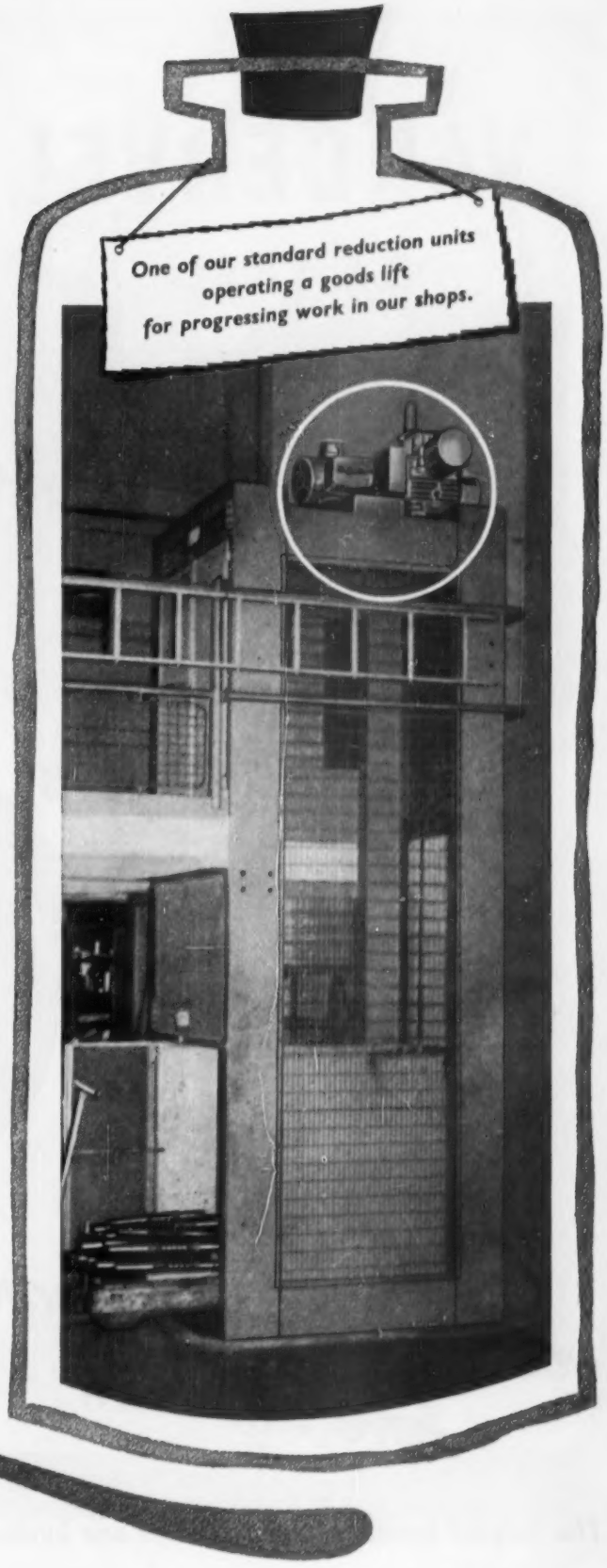
Thompson

Fully patented

AUTOMOTIVE PRODUCTS COMPANY LIMITED, LEAMINGTON SPA, ENGLAND

Taking our own medicine

Our own Worm Units are busy at work all over our Milnrow factory. And you'd think someone had given us summat for nowt to see how pleased we are about it. It's partly pride—they're our *own* Worm Units — but mainly because they do the various jobs so very well. They're made to a formula which includes efficiency (a Holroyd Worm and Wheel hold the world record), reliability, and 50 years' experience. This prescription might do *you* a power of good, and it can be . . .



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A Standard Type Holroyd Worm Reduction Unit can be made up from stock, packed, despatched, and delivered to you within a few days. Worms, wheels, and special units made to order take a bit longer. For information on Worm Units and applications (and we're discovering new ones every day, like the Goods Lift in the illustration) drop us a line at Milnrow, Lancs. We'll be glad to help you all we can.

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CBC 171

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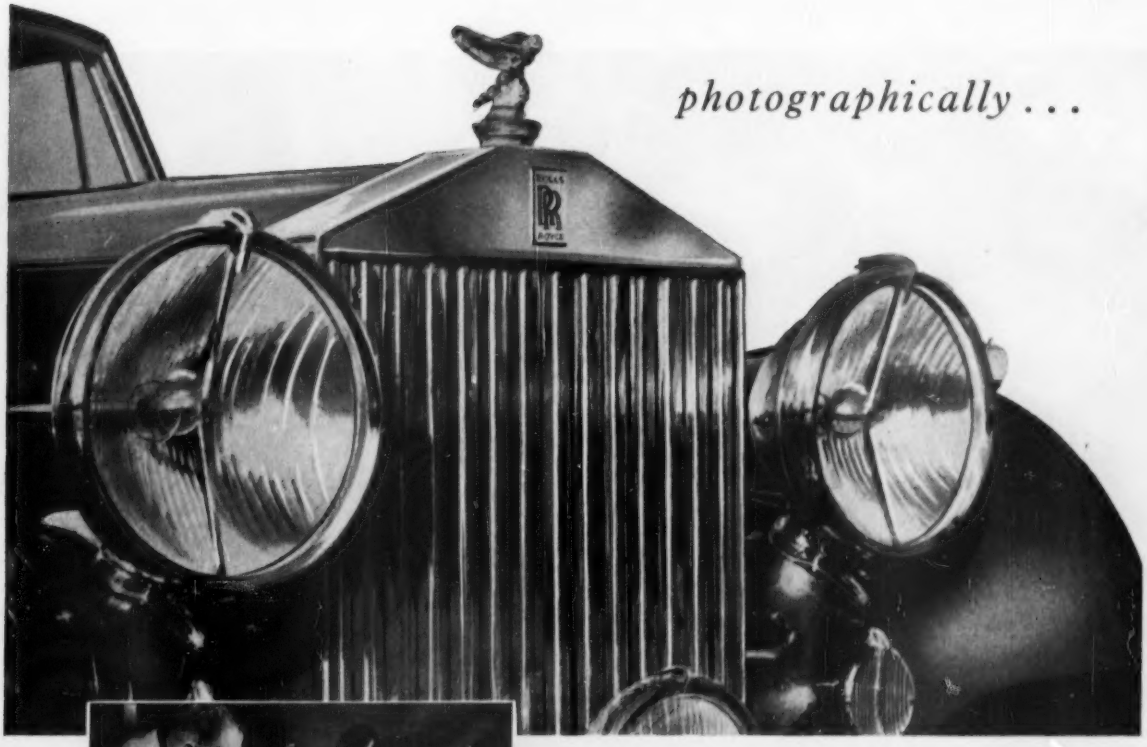

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* *The Ilford Technical Information Book is an indispensable work of reference for all engaged in industrial and scientific photography. It contains full technical data for all Ilford sensitised materials with useful information on exposure, processing and the various technical applications of photography*

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assure high drilling rates on coal cutter gear boxes at
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Sizes from 4 ft. to 7 ft. radius for drilling up to 3 in. dia., in steel.
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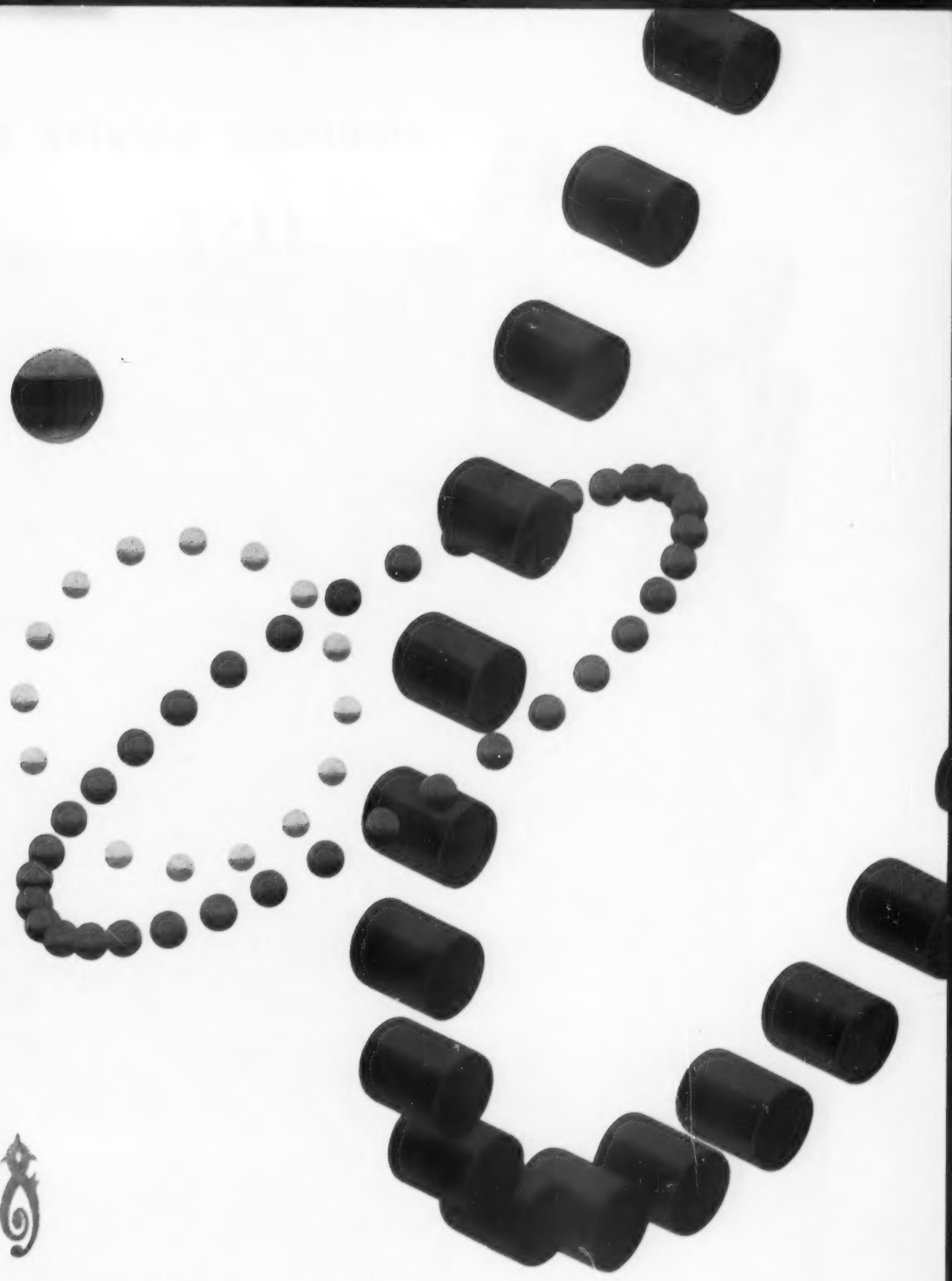

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For more than a generation Ransome & Marles have been meeting and solving bearing problems where reliability and accuracy are essentials. Our research staff are meeting tomorrow's problems today.

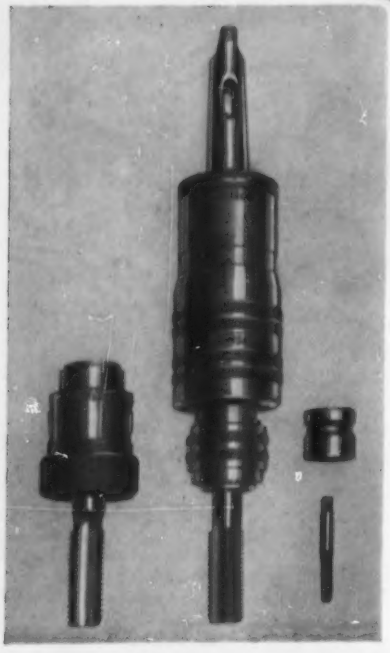
BALL & ROLLER R&M BEARINGS

RANSOME & MARLES BEARING CO. LTD., NEWARK-ON-TRENT, ENGLAND

eliminate tapping problems

USE THOMSON TAPPING ATTACHMENTS

Shown left are the two sizes of the special Thomson Tapper for capstans. The bodies are "shortened" so that the Tapper does not protrude beyond the normal arc of turret tooling. This feature is illustrated below with the larger model (CP2, ¼in. to 1in. Whit. or ANC), fitted to a capstan lathe. The smaller model, CP1, has capacity ⅛in. to ¼in.



on radial drills
horizontal borers
lathes
jig mills

Thomson Tapping Attachments use standard hand taps and are supplied with adaptors to cover each range. Left, the standard attachment; in three sizes: **T.1**, ¼ *to* 1¼*W;* **T.2**, ⅜ *to* 1½ *W;* **T.3**, $\frac{3}{16}$ *to* ½ *B.S.F. (Combination models are available for tapping, drilling, reaming, countersinking, spotfacing, stud driving, and similar operations.)*

Costly tap breakages, wandering and stripped threads, are among the many aggravating tapping problems which can be overcome by equipping with Thomson Tapping Attachments. Their application is simple and they are adaptable to any form of tapping. Precise torque setting, without guesswork, by easy nut-adjustment, allows the Tapper to be set quickly to the correct value for tapping in any material. Long life of the Thomson, even in heavy duty operation, is assured by robust construction, an internal oil bath for consistent lubrication, and careful sealing against swarf.

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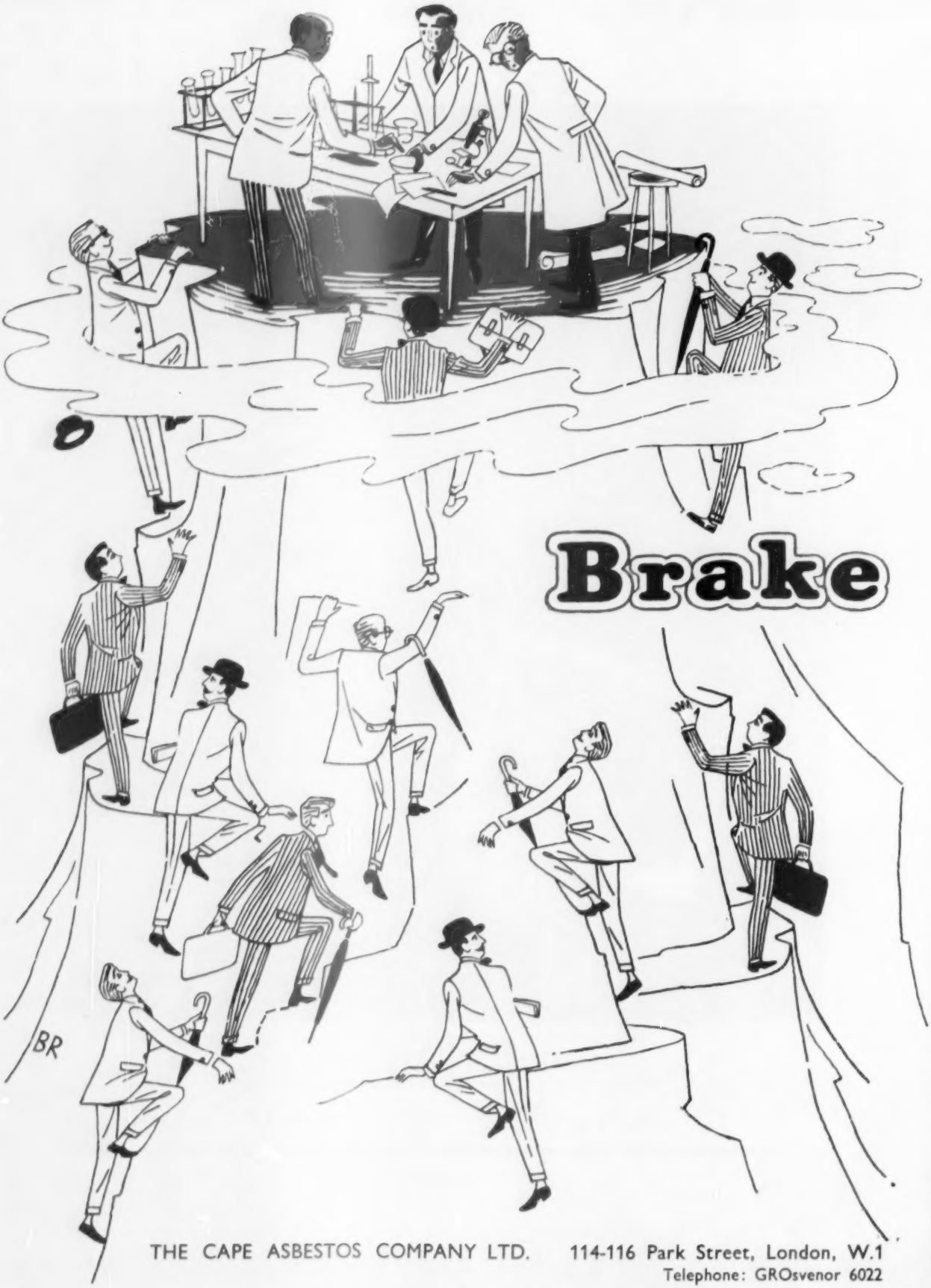

THE CAPE ASBESTOS COMPANY LTD. 114-116 Park Street, London, W.1
Telephone: GROsvenor 6022

with tradition

It may be unfair to suggest that research people spend their time up in the clouds. It **is** fair, though, to say that they never exactly welcome visitors. So we are definitely breaking with tradition in inviting them (as we do now) to step down for a minute and take a little applause. No-one has done more for the CAPASCO tradition of dependable braking than they have; and everyone who has experienced the smooth, controlled, fade-free action of CAPASCO linings knows just how much that compliment implies.

CAPASCO

MOULDED BRAKE LININGS

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Please!

Let's get this question of 'Woven or Molded' straight

Preference MAY enter into it

but — straightforward NEED decides whether woven or molded brake liners should be fitted. (Note: — WE CAN SUPPLY BOTH). It takes you, to weigh up the various points (the type of vehicle, its braking equipment, and the conditions under which it is likely to be operated) that decide which precise quality of either type is required. And that is where we can advise. Our range of both *molded and woven* liners will meet the braking needs of any vehicle: and our Technical Staff will see that you get the *right* liner for the job.

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for heavy continuous production

TWIN CURRENT RANGE

65 volt range, suitable for most mild steel welding rods for currents from 50–300 amps.

95 volt range, for currents up to 220 amps.

CURRENT REGULATION

Infinitely variable over each range. Adjustment by handwheel; indicator drum readable from sides and from above.

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Low stresses in the electric materials keep the losses down and a strong natural draught ventilation results in low machine temperatures.

RATED FOR TOP SETTING

The 'Media' has been rated according to B.S.S.638/1941 for continuous hand welding at its maximum current. It is designed to take heavy punishment.

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The transformer is fitted with wheels and castors and is easily pushed and guided.

ELECTRODES

A wide range of Actarc electrodes is available. There are lime-ferritic electrodes for welding medium carbon and low alloyed steel; mild steel electrodes for general purpose work; special rods for vertical and overhead welding, and for deep penetration; electrodes for fast horizontal production work; electrodes for boiler plate; non-ferrous electrodes for aluminium, nickel and bronze.

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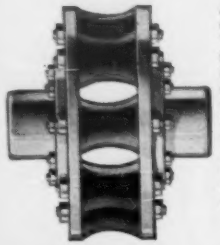
Delicate, complete mouldings to critical dimensions; accurate in every respect; exact in operation. When such problems come to mind call on EMPIRE RUBBER COMPANY. Their increasingly wide variety of rubber components, produced to every sort of industrial specification, do a great deal towards helping machinery run more silently, smoothly and—above all—economically.

These are but two of many available examples of what can be done to bring rubber in as an integral part of a machine.



A metal fixing-piece is bonded to each end of a cylinder of rubber. The cylinder then supports the load in shear or compression—at the flexibility you want. This is a very elementary example of the many productive ways in which rubber-bonded-to-metal components are used. RUBBER BONDERS LIMITED were pioneers in this growing industry. Today they lead both in quality, resourcefulness and variety of products.

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R.B. 89

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In this way they can detect gas cavities, slag inclusions and other possible defects, and so by constant inspection, ensure the most dependability in Harper Castings.

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H450

Seals of Authority

Elizabeth I.

"England for the English" was the principle of Queen Elizabeth I. She safely piloted England through the struggle to assert its national independence in religion and politics. She also established England's claim to share in the new inheritance which had been opened up for the nations of Europe. By the end of her reign in 1603, Englishmen were to be found in every quarter of the globe.

The Authority on Seals

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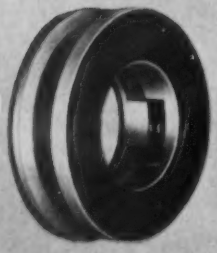
In leather and synthetic rubber for all requirements; from 1/4" up to 36" shaft; in built-up type or bonded.

"ROMET" FACE TYPE SEALS

For all water pump and similar applications.



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For arduous duty. Suitable for bogie wheels and idler wheels for track vehicles.

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For all types of hydraulic and pneumatic applications.

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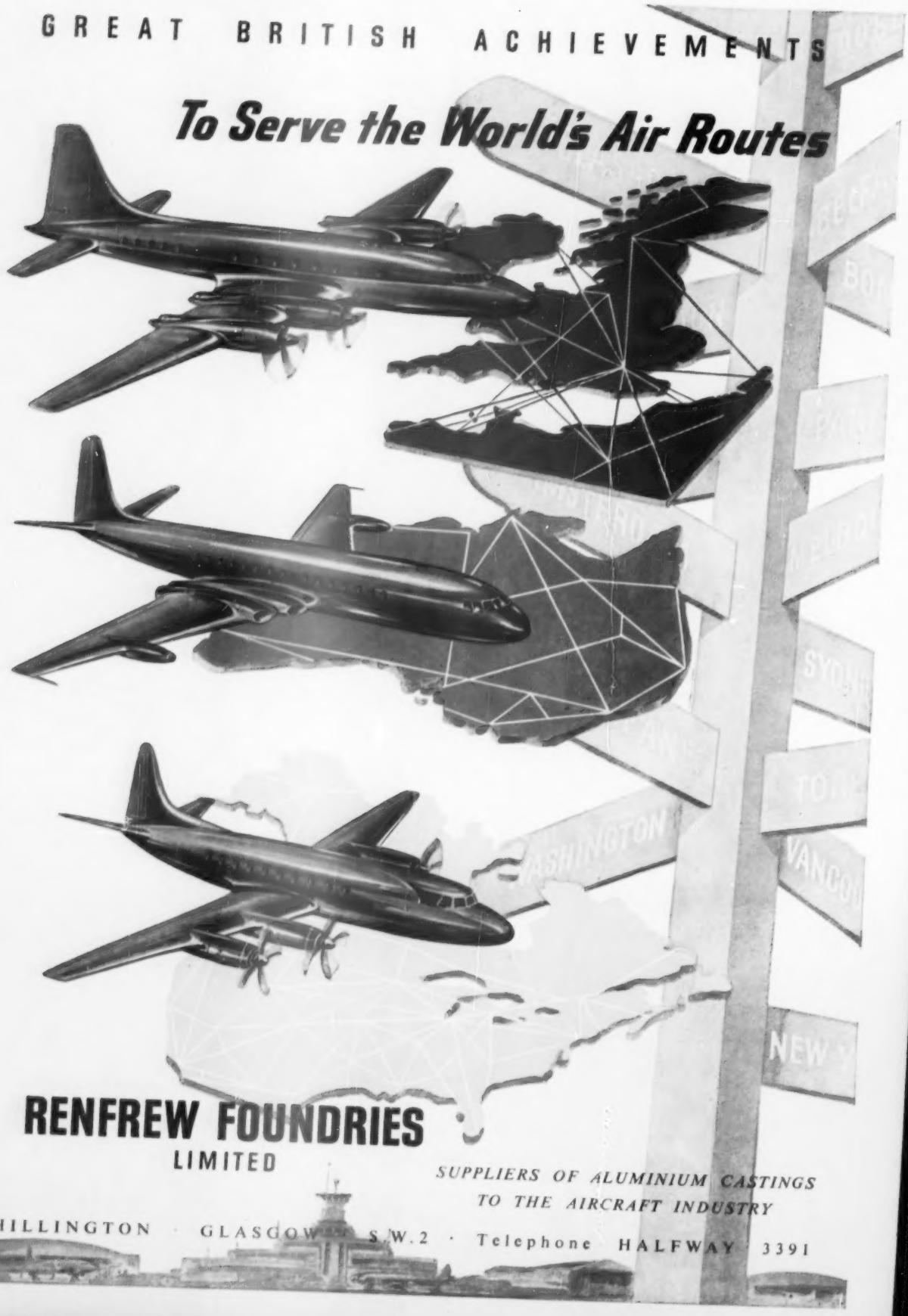

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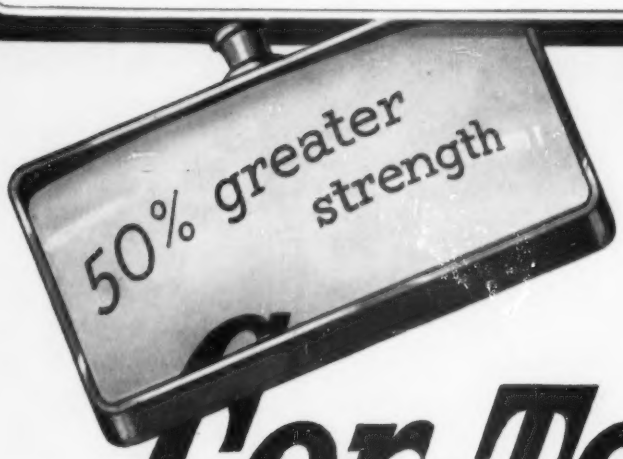
CONSTRUCTION CAN BE LIGHTER WITH COR-TEN



Cor-Ten Brand STEEL

AS DEVELOPED BY THE UNITED STATES STEEL CORPORATION

Cor-Ten is a low-alloy steel of consistent character, combining a high tensile strength with a high resistance to corrosion.

Weight can be saved in two ways. Firstly because thickness, compared with that of mild steel, can be reduced without loss of strength. Secondly, Cor-Ten steel has four to six times the resistance to atmospheric corrosion, quickly forming a self-protecting skin. Allowance for loss of section due to corrosion is thus reduced to a minimum.

Yield point ranges from 20 tons per sq.in. for cold-reduced sheet, to 22 tons per sq.in. for hot-rolled plate and sheet $\frac{3}{8}$" and thinner.

Elongation and cold-bend figures are good; working and welding qualities are excellent and so is resistance to abrasion, impact and fatigue.

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'COR-TEN' IS A REGISTERED TRADE MARK

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AND

THE STEEL COMPANY OF WALES LTD.

TRANSMISSION
at it's best
Layrub transmission is being adopted more and more by the leading commercial vehicle manufacturers. It gives a true cushioned transmission, having no metal-to-metal contacts, no sliding spline, therefore, little or no maintenance. Write us for our technical catalogue which we shall be pleased to mail you.
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for

high speed threading . . .

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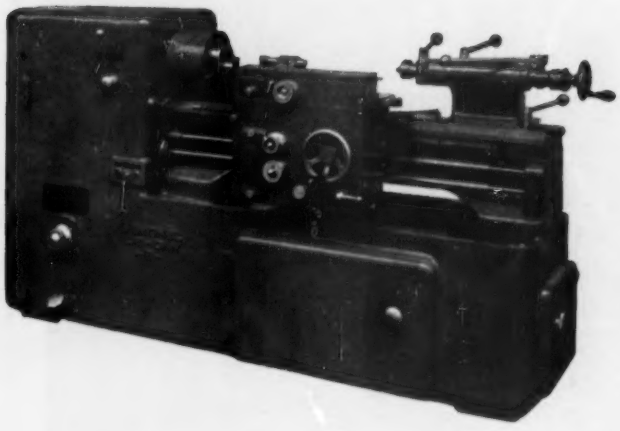
accurate and highly finished threads produced . . .

USING a single-point tungsten-carbide tool, external or internal, single or multi-start, right- or left-hand, parallel or taper, special or standard forms can be cut in most materials.

Maximum thread diameter 4″ (external), 6″ (internal); 3′ 0″ admitted between centres.



Typical production obtained is shown at:—

A. Focusing mount, aluminium. Spiral groove ·100″ wide × ·050″ deep, $\frac{1}{2}$″ lead, 2″ long on $1\frac{3}{8}$″ diameter. Cutting time 11 seconds.

B. Diesel Stud, 70 tons tensile steel. $\frac{7}{8}$″ × 11 t.p.i. Whit. $1\frac{3}{4}$″ long. Cutting time 17 seconds.

C. Adapter, mild steel. $1\frac{3}{8}$″ × $\frac{3}{8}$″ long (internal) $1\frac{5}{8}$″ × $\frac{1}{4}$″ long (external), 14 t.p.i. Whit. Cutting time 8 seconds (two threads cut simultaneously).

D. Hose coupling, phosphor bronze. $2\frac{3}{4}$″ × $2\frac{1}{4}$″ long, 8 t.p.i. Whit. and $3\frac{1}{8}$″ × ·280″ deep × $1\frac{3}{8}$″ long, 2 t.p.i. Knuckle. Cutting time 25 and 40 seconds Whit. and Knuckle respectively.

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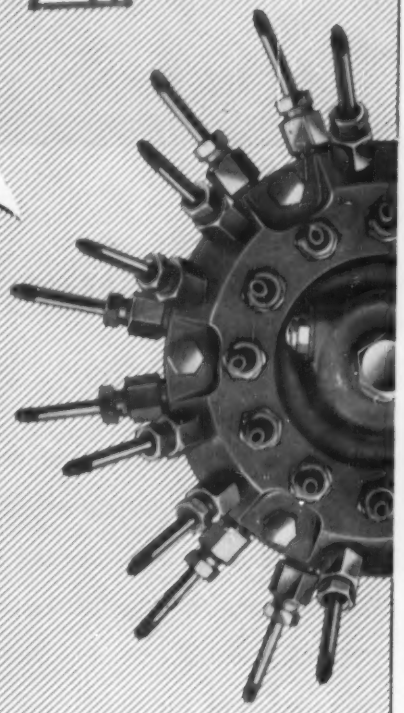

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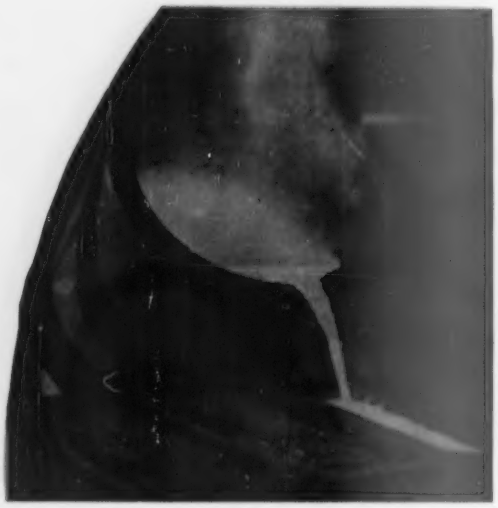

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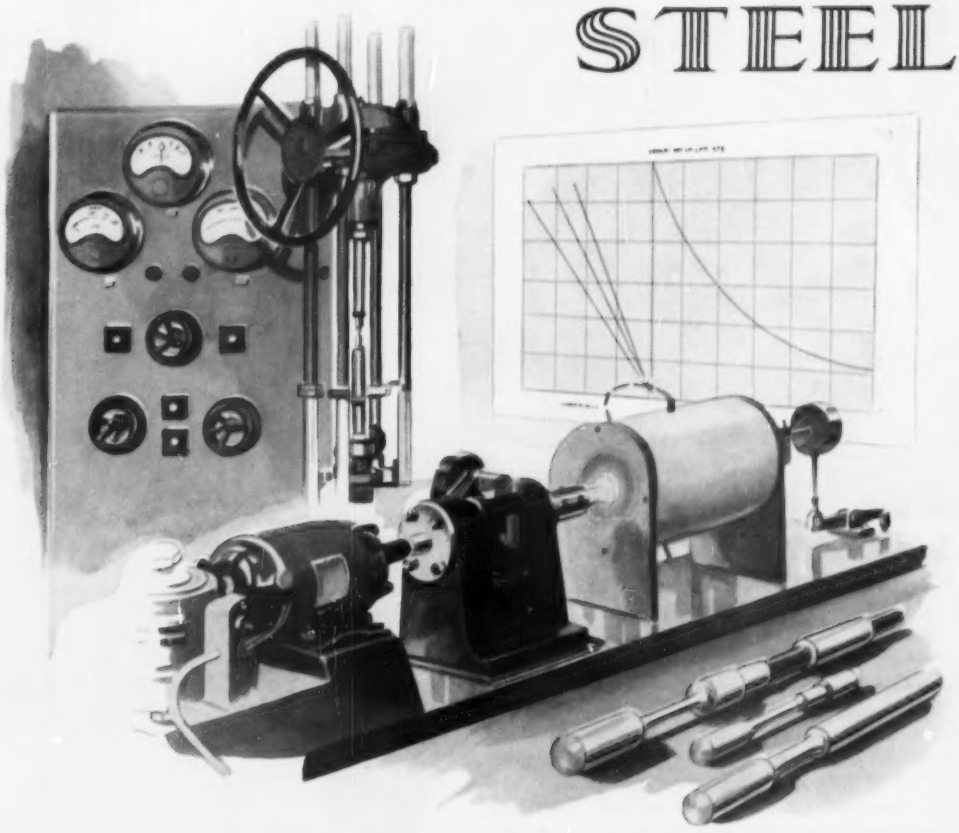

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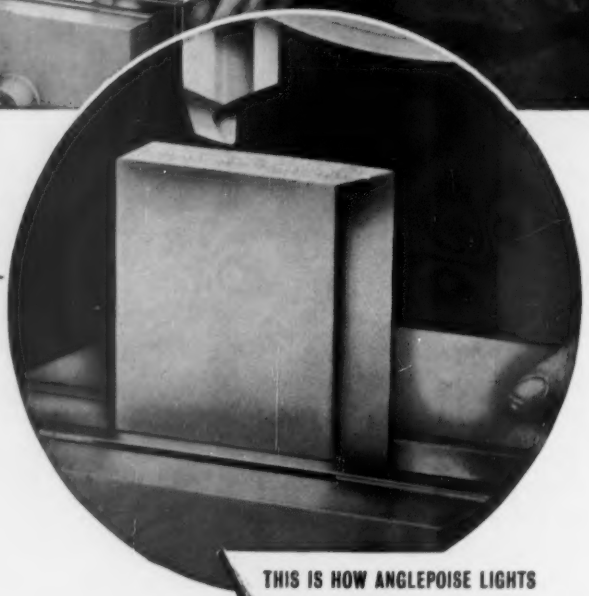

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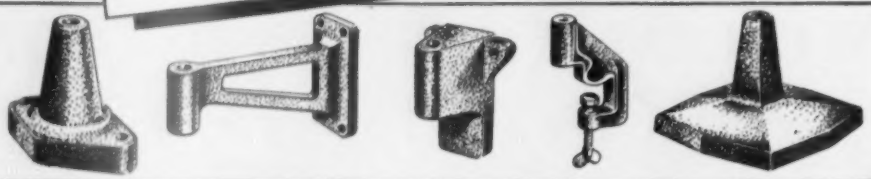

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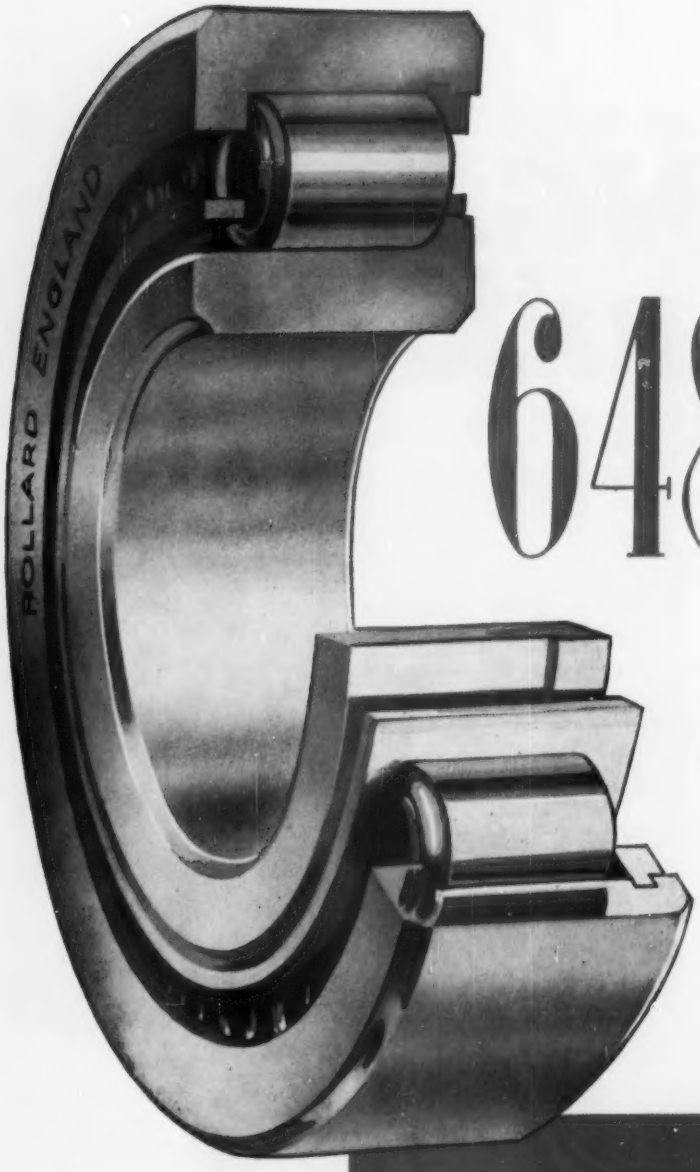

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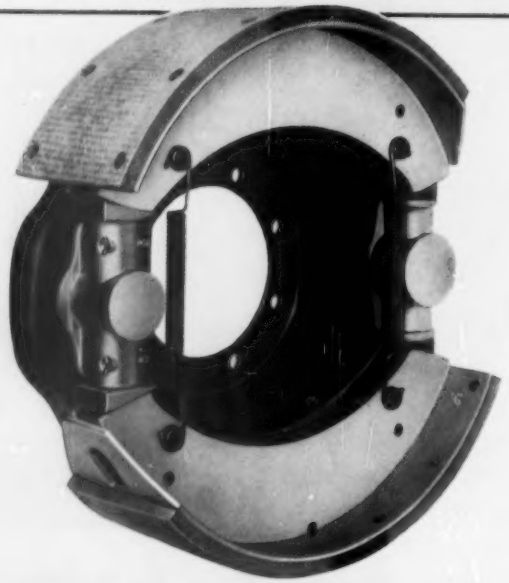

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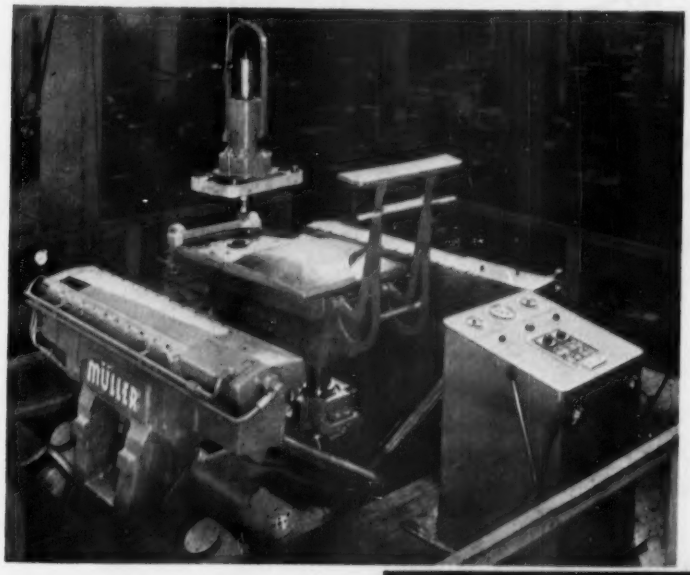

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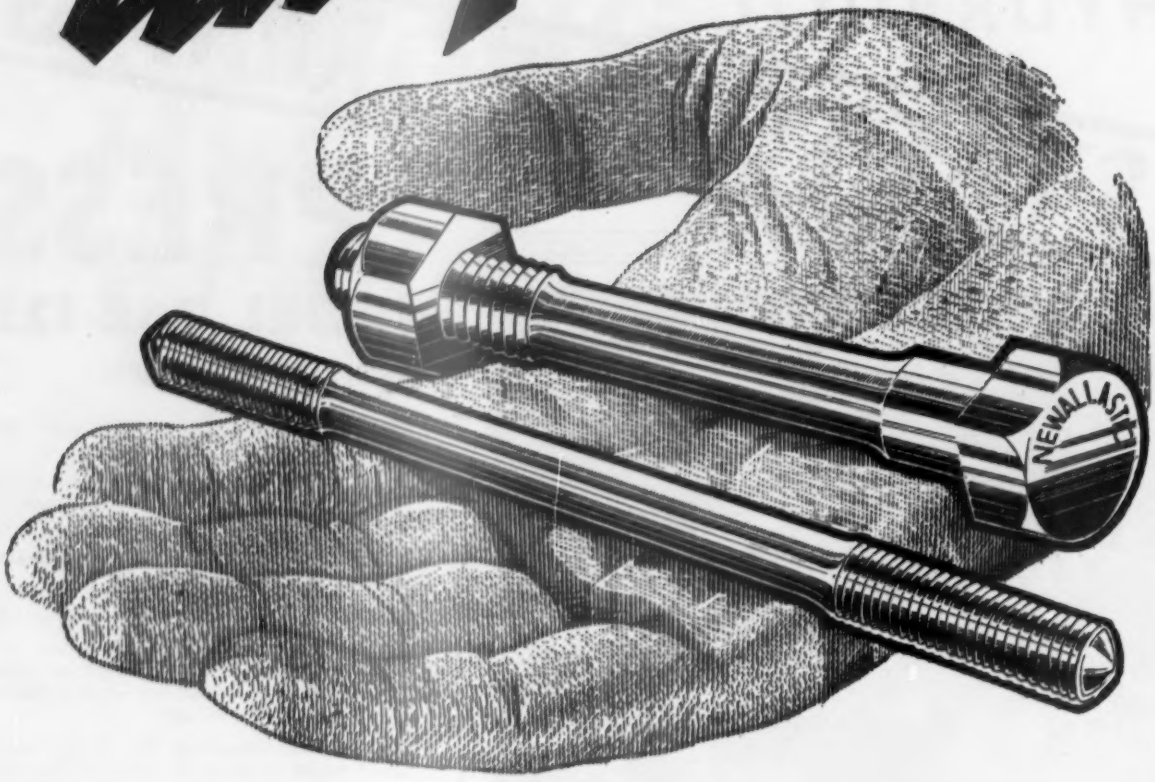

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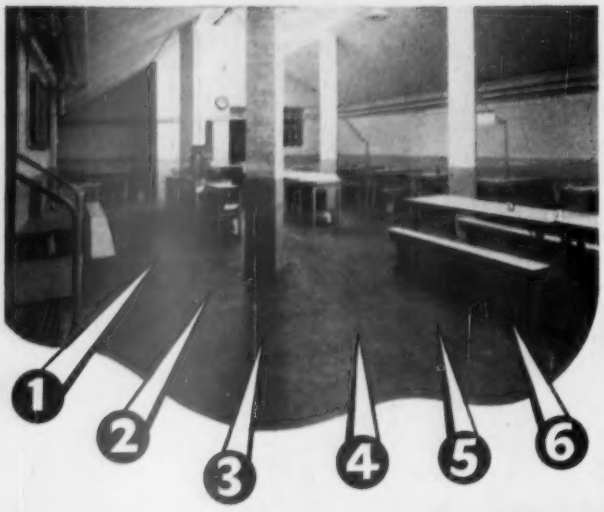

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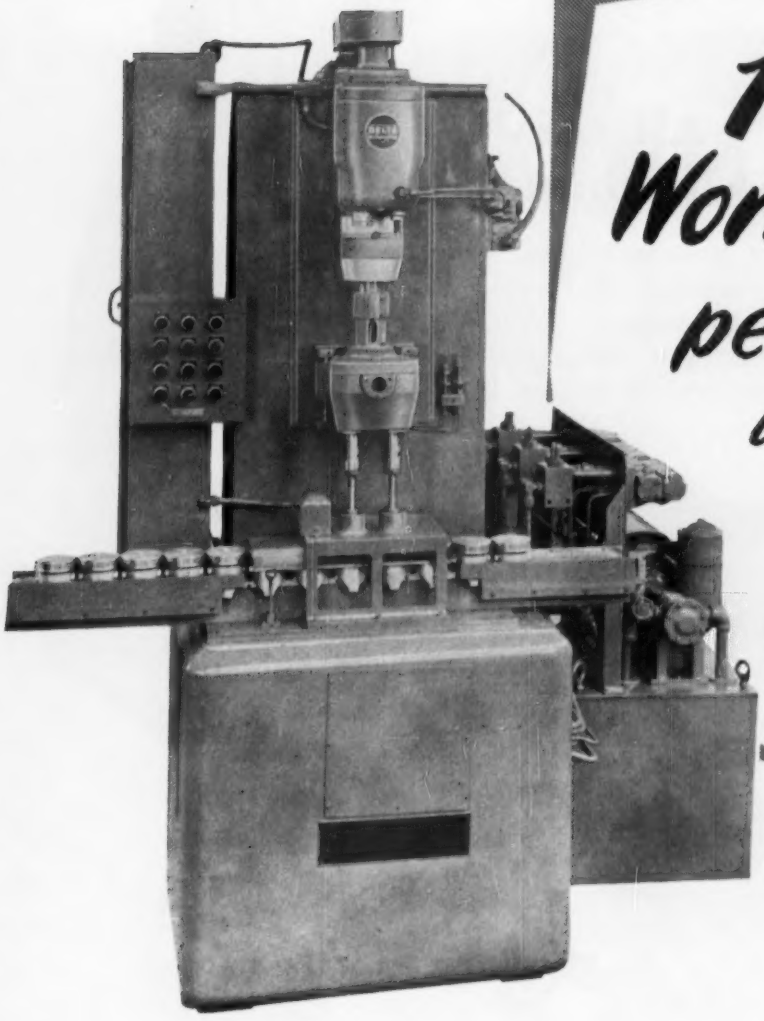

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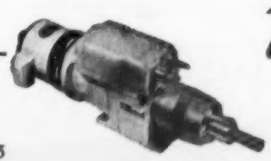

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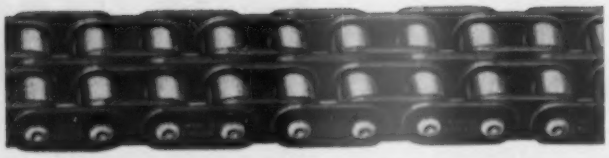

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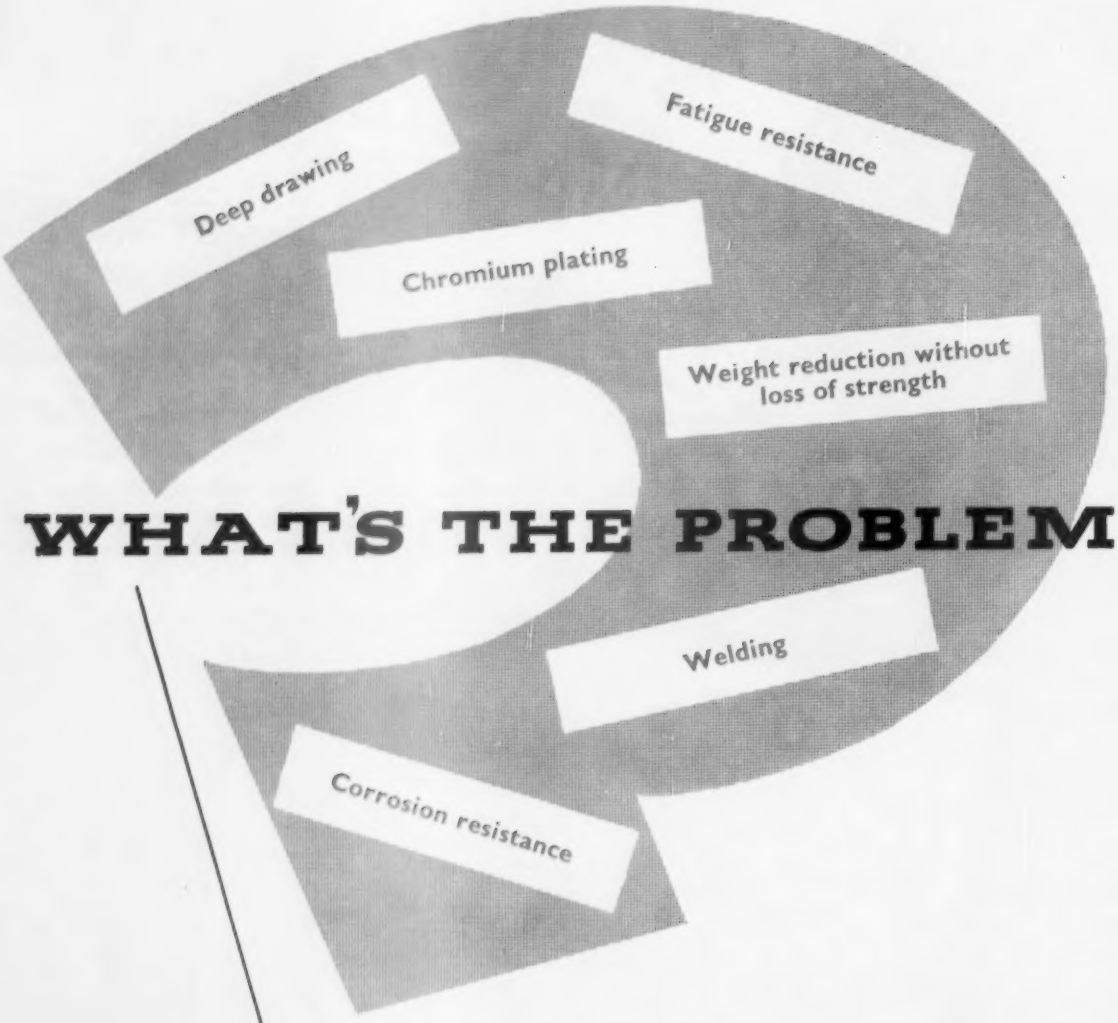

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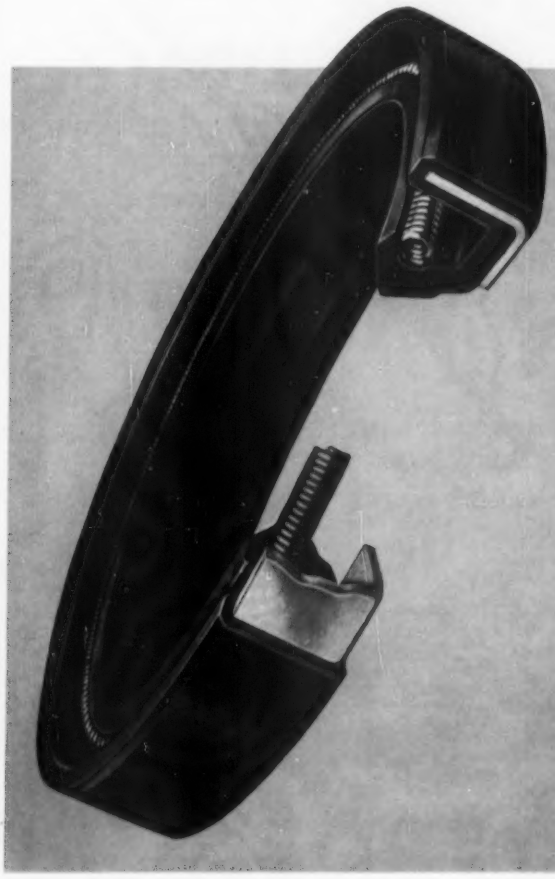

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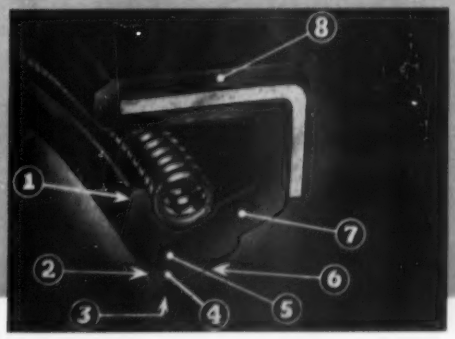

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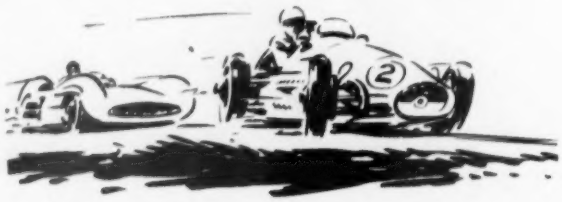

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ANTI-FADE Brake Linings

Ferodo First – to last!

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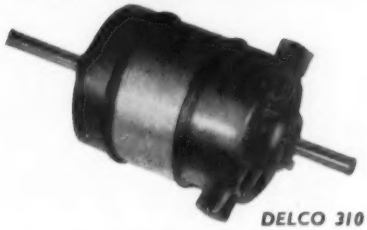
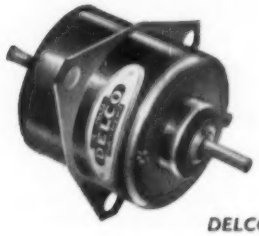
DELCO motors

DELCO 6½" TYPE



DELCO 310 TYPE



DELCO 258 TYPE
with flange mounting

Before you start work on your plans for Automobile applications which call for compact, high-efficiency electric motors. . consult Delco engineers. The Delco range includes motors to meet most modern requirements—from car heaters to axle gear shifts. These versatile motors are so designed as to be easily adapted to suit your individual needs.

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(Photograph by courtesy of Leyland Motors Ltd.)

(The Names 'Heenan' & 'Froude' are registered Trade Marks of the Company)

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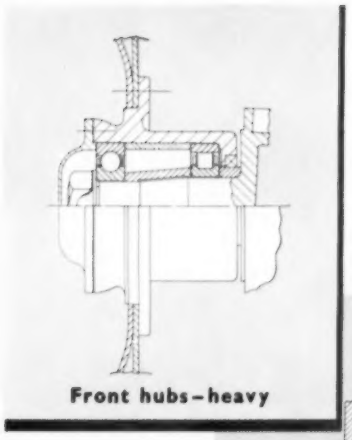
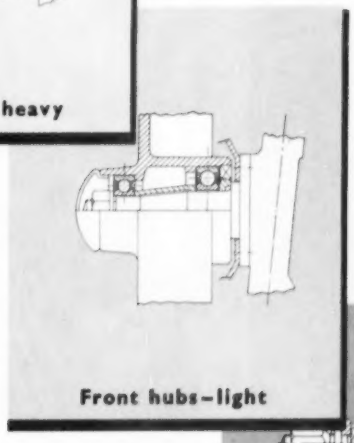
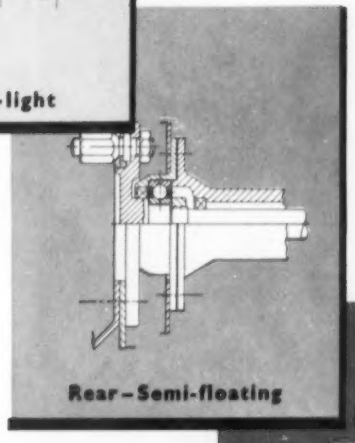
Engineers : WORCESTER : England



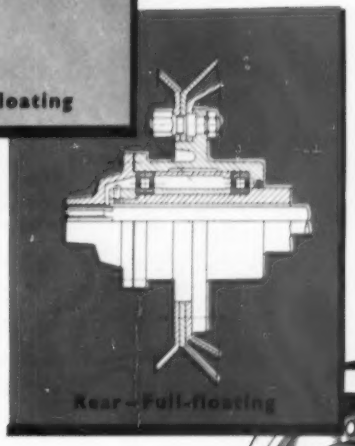
Front hubs–heavy



Front hubs–light



Rear–Semi-floating



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Counsel's Moving Speech

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Coventry Motor Sundries

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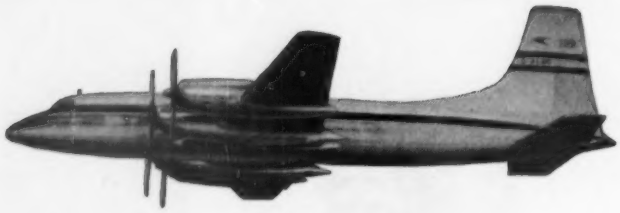

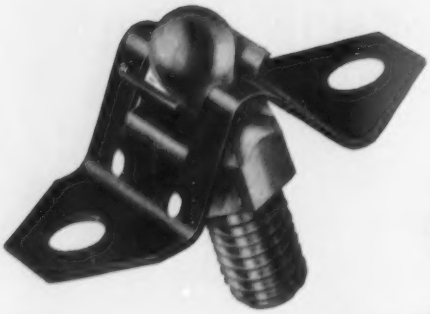

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12,924 Spire Parts are used in the assembly of every Bristol 'Britannia'— for several very good reasons. Spire Fasteners reduce the weight of materials used by as much as half. And they substantially cut labour costs by doing away with difficult and expensive operations, especially in blind assembly work. In other words, they save weight, time and money.

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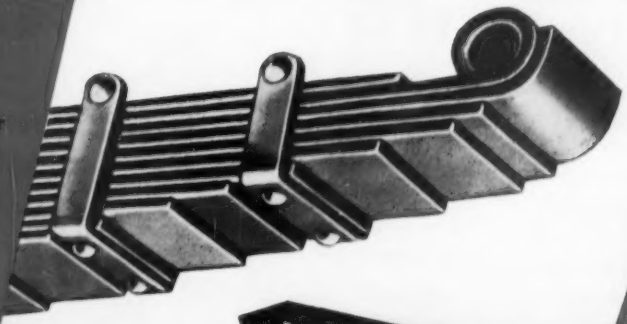
Coil, laminated and torsion bar springs are manufactured by Toledo Woodhead for every type of automotive vehicle — with shot blast treatment for longer fatigue life if required. We also supply Tine springs for cultivator and agricultural implement manufacture.



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Consequent upon the conclusions reached by the Road Research Laboratory in an exhaustive investigation into the subject of safe rear lighting, The Road Transport Lighting Act of 1953 calls for the fitment of two rear lamps and two reflectors of specified performance, to all British cars and Commercial vehicles.

Rearlamps 1955

- Increased rear light intensity, achieved by the incorporation of lensing in precision mouldings of high light transmission factor.
- Improved "stop-light" braking indication - due to lensing and advancements in bulb construction.
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- Lucas Reflex. Reflectors are moulded to extremely fine dimensional tolerances, the reflecting surfaces being designed to produce an intense reflected beam directed to the vicinity of the light source.
- Lucas modern rear lamps and Reflex Reflectors are designed to meet the requirements of world-wide specification.

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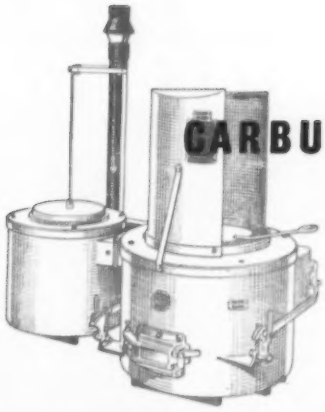
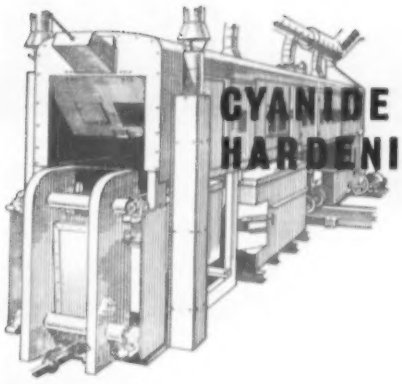


CARBURISING



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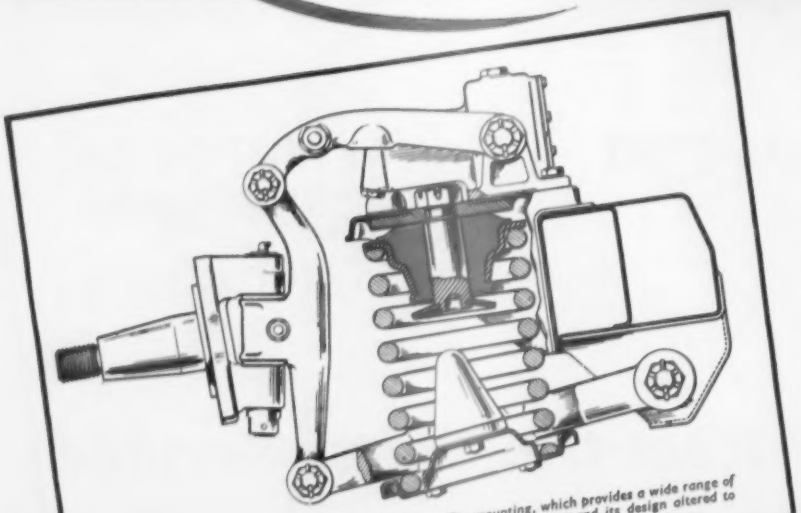
C.C.163

Silentbloc FRUSTACON..

. . . the first scientifically designed flexible mounting fitted to the I.F.S. of a Production Car

The 'Frustacon' mounting fitted to the I.F.S. of the 1952 Rover '75'. Sectioned to show rubber.



Silentbloc "Frustacon" fitted in an I.F.S. System. The mounting, which provides a wide range of deflection rates, may be fitted at the top or bottom of the coil spring and its design altered to suit any system.

To minimise the transmission of road noise to the body by the coil springs, Silentbloc Frustacon mountings have been incorporated in the I.F.S. of the 1952 Rover '75'. This notable step forward in the reduction of noise is another example of co-operation between car manufacturers and Silentbloc Ltd.

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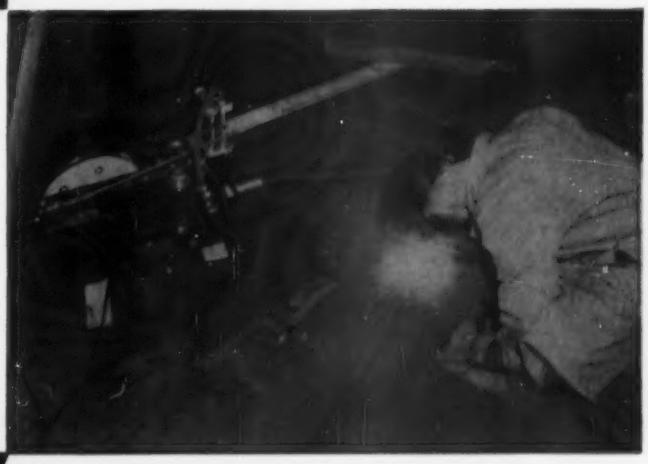

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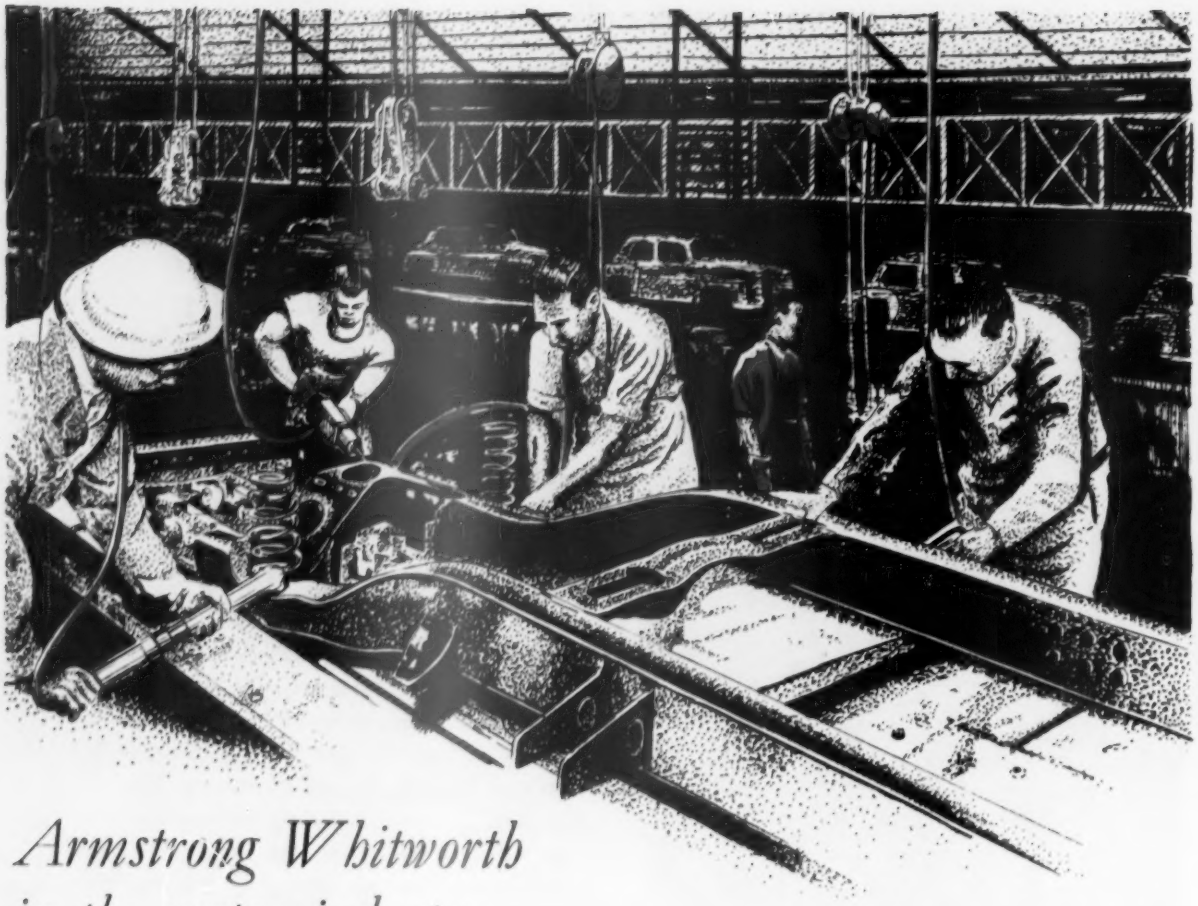
LONDON & BRANCHES



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Armstrong Whitworth tools are designed for the manufacturer—with the operator in mind.

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P.67 R.15

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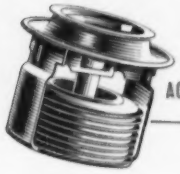

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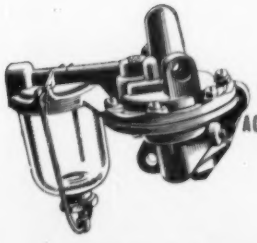
AC SPARK PLUGS



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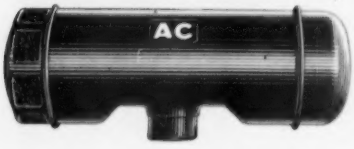

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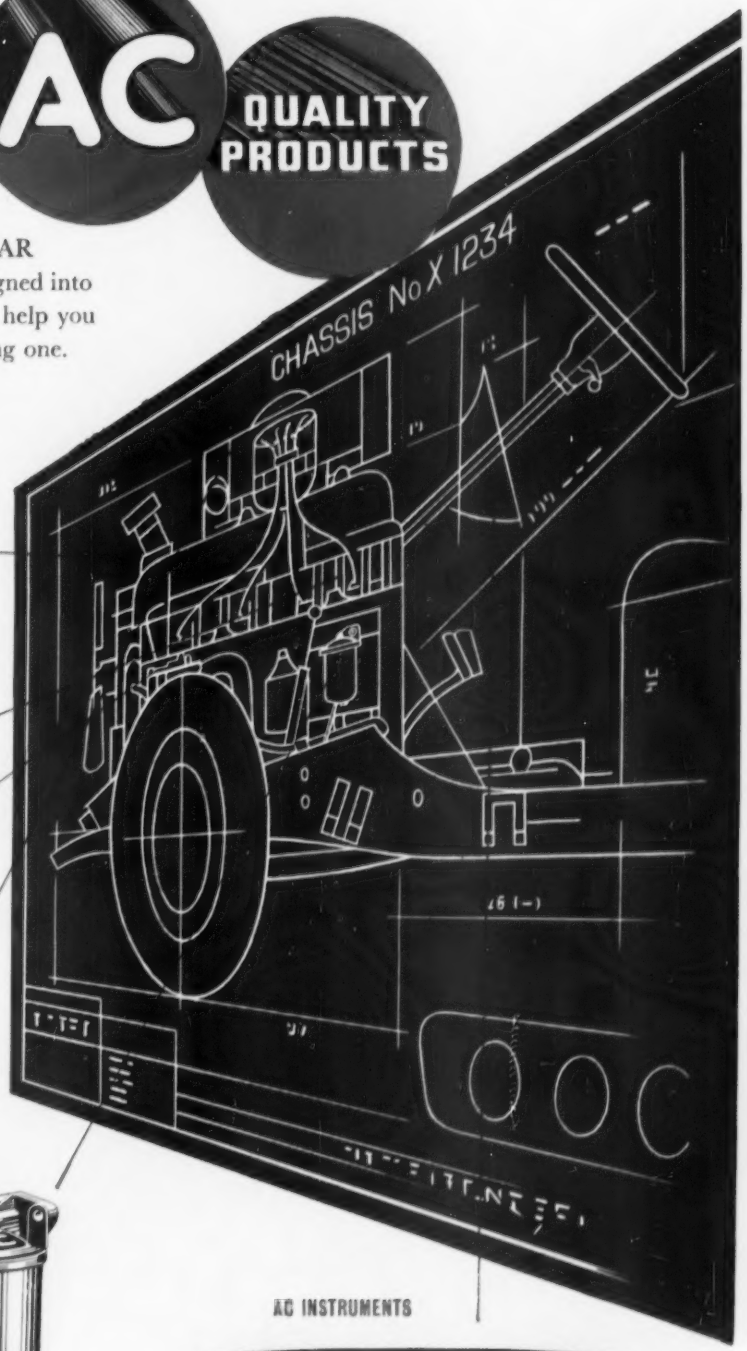

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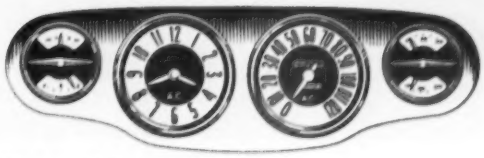

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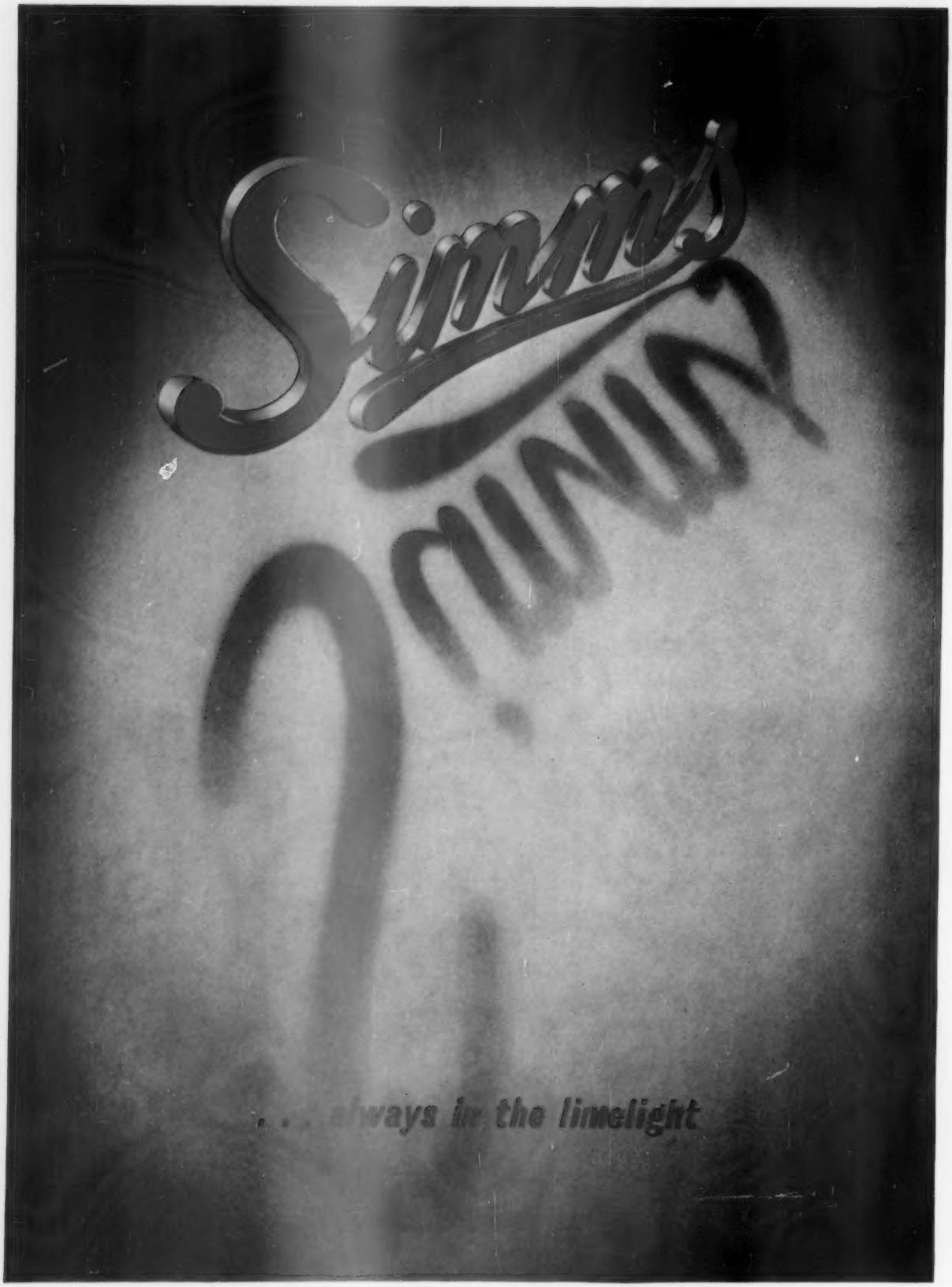

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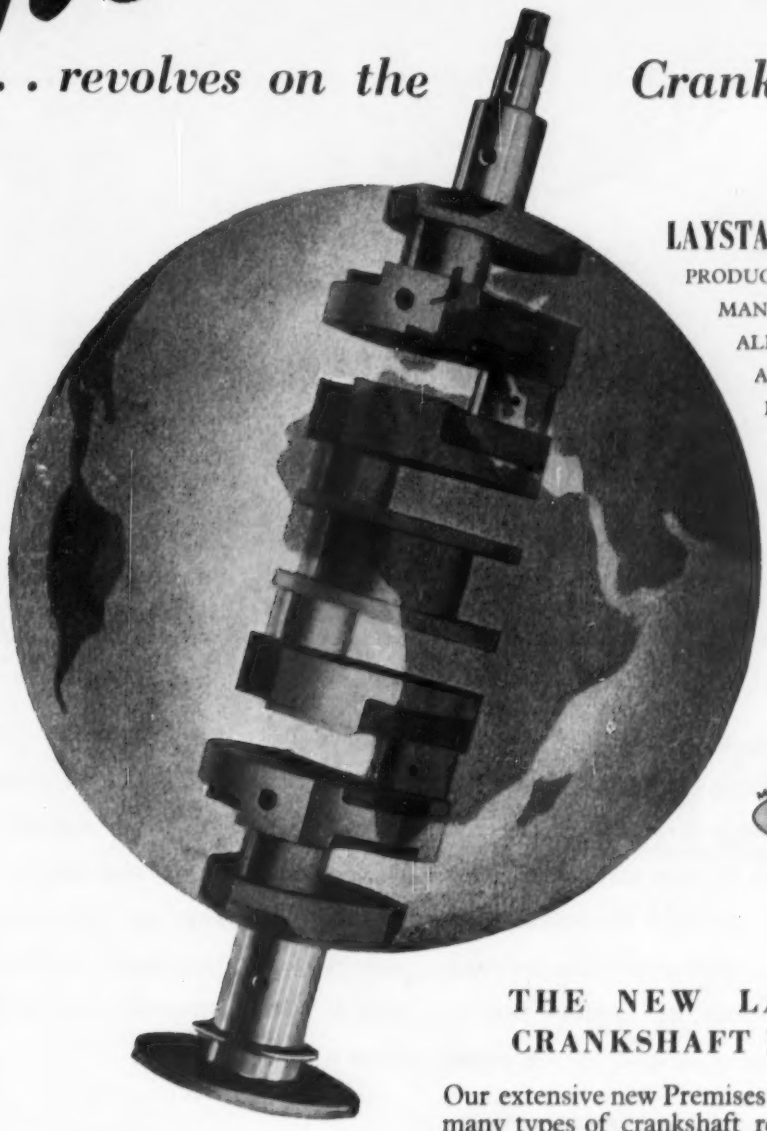

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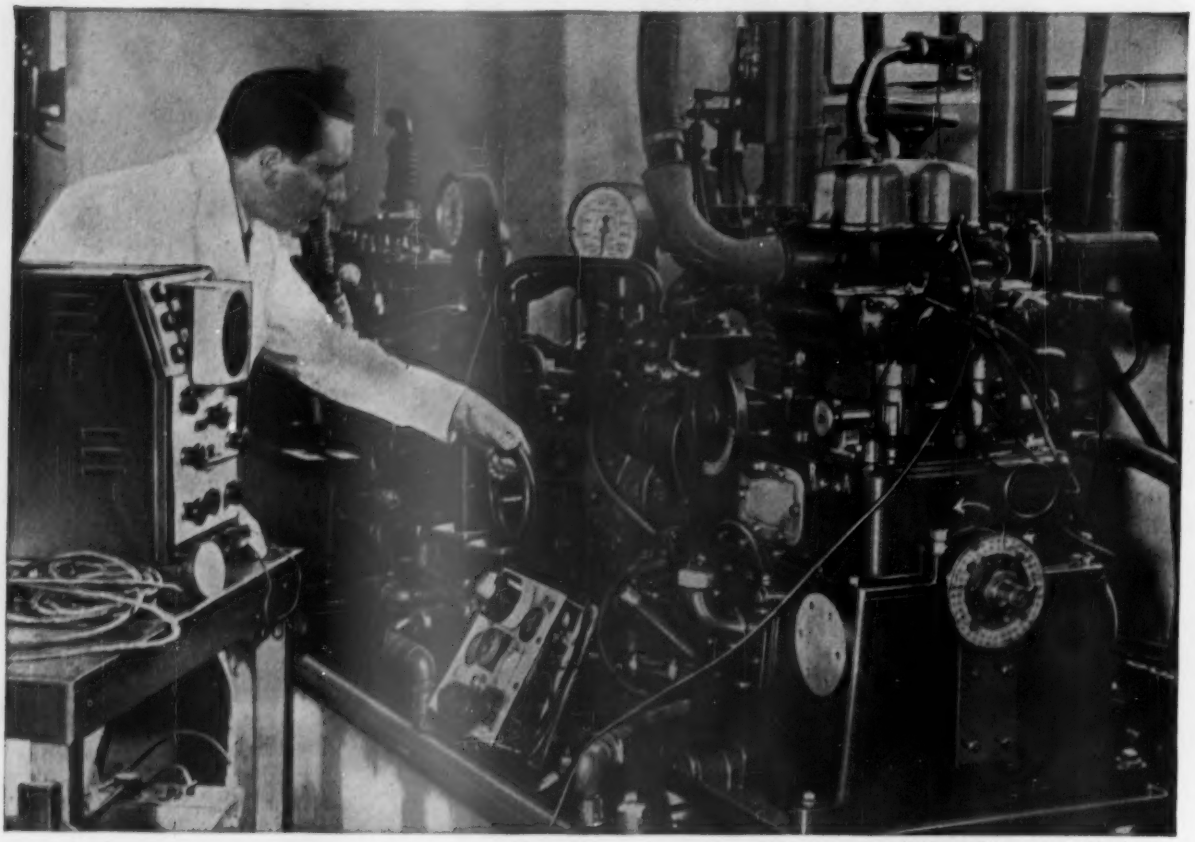

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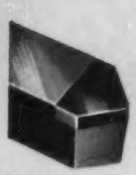

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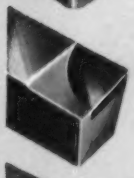

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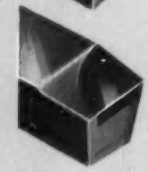

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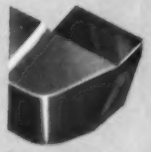

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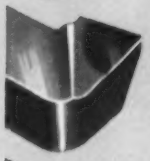

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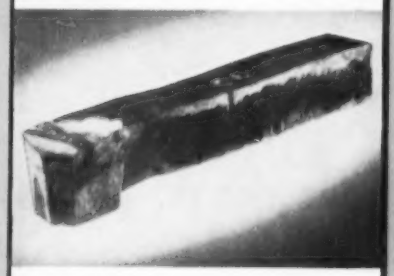

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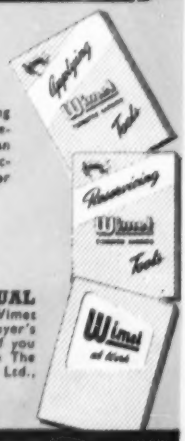

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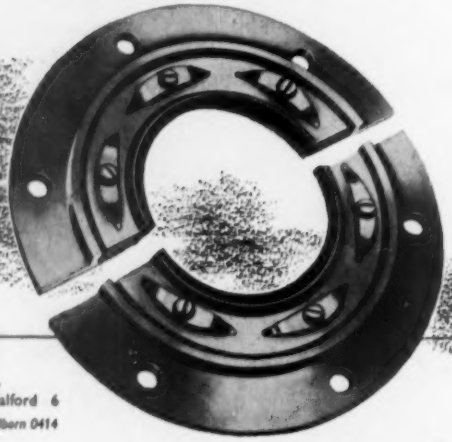

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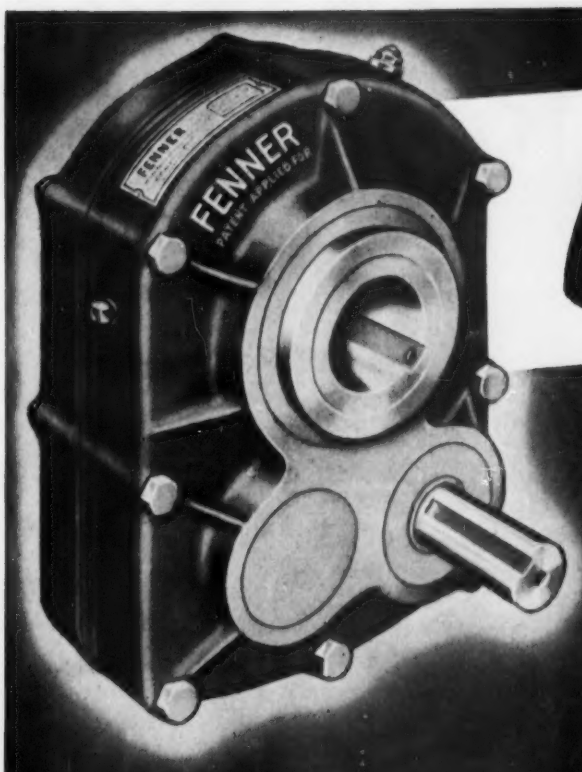

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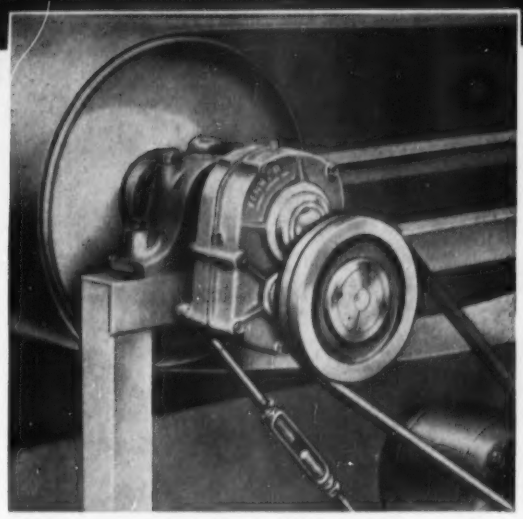

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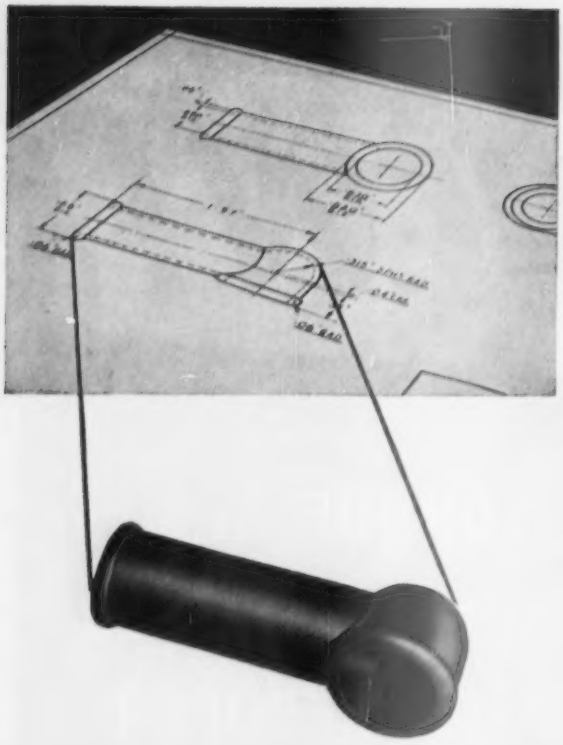

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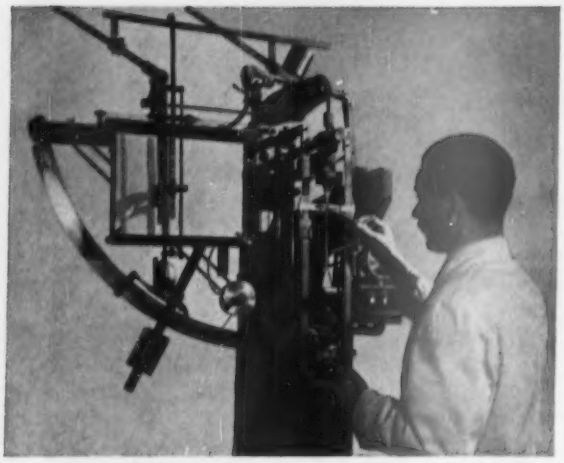

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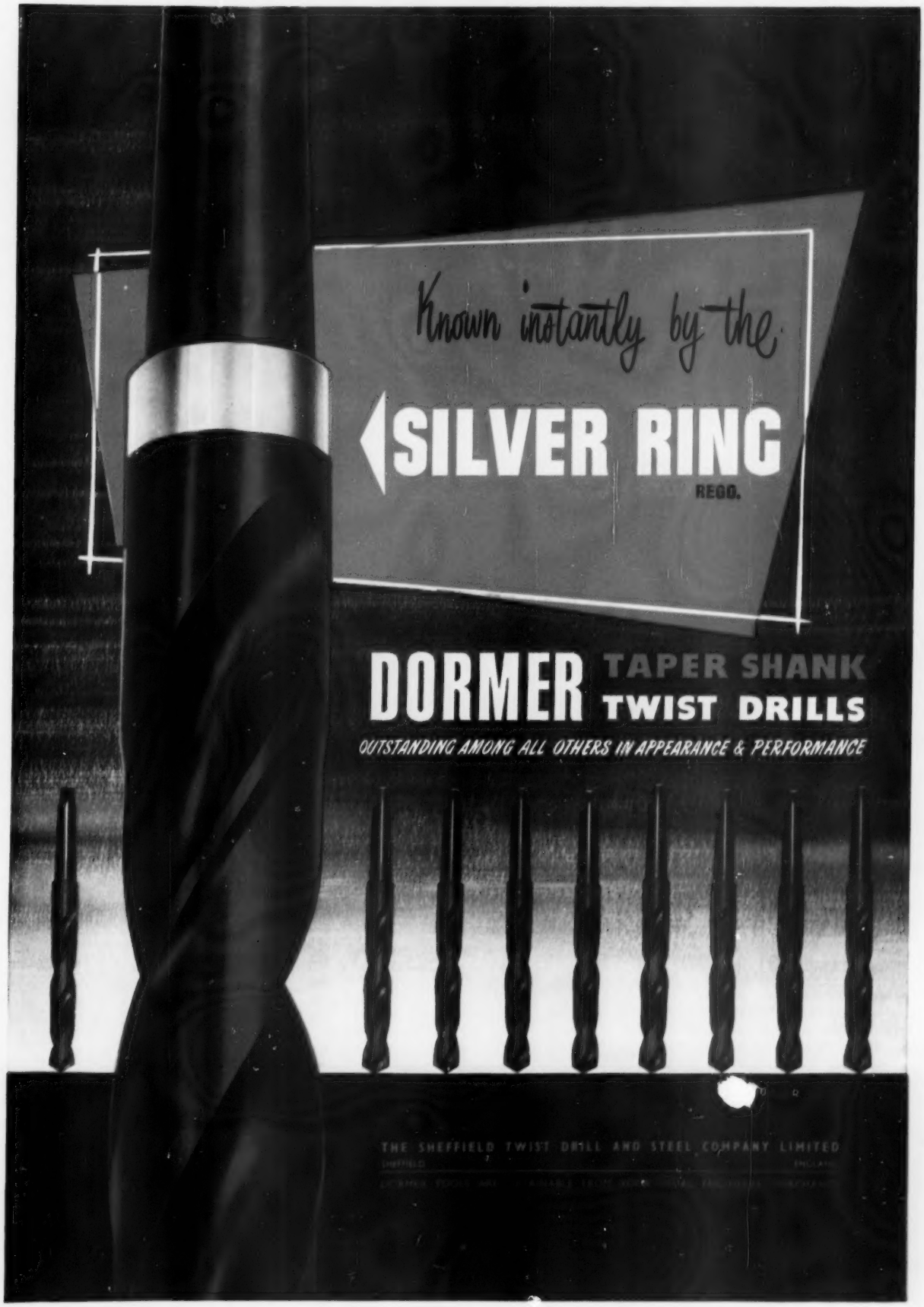
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AUTOMOBILE ENGINEER

Design, Materials, Production Methods, and Works Equipment

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Developments for 1955

THAT there is a spirit of reasoned optimism in the future of the British automobile is proved beyond doubt by the several schemes for increased capital investment during the next five years. Projects involving expenditure in the order of £65,000,000, the figure quoted by the Ford Motor Co. Ltd., are not lightly undertaken. General Motors Corporation must also have faith in the future of the industry in this country, since they plan to spend £35,000,000 in modernizing and extending the Vauxhall plants. The other members of the Big Five, British Motor Corporation, The Rootes Group and the Standard Motor Co. Ltd., have not disclosed definite figures, but that they are also planning large scale projects is an open secret.

It is clear that most of this additional investment will be used to boost production and there is a probability that the yearly output potential for passenger cars alone will be in the order of 1,000,000 units at the end of another five years. There will be a lesser, but none the less appreciable, increase in the output potential for commercial and public service vehicles. If production facilities are used to the full, the car owner will undoubtedly benefit by getting better value for his money. However, if this desirable end is to be reached, design developments must keep pace with production developments. It is therefore not without interest to consider the lines along which development might most profitably be pursued.

Heavy vehicles

The interest already shown in automatic and semi-automatic transmissions, particularly for public service vehicles, could well be intensified. Despite the higher cost of these systems, there are good reasons for favouring their wider adoption. They can greatly ease the driver's work and should make it easier to engage the class of labour that is required. They will also reduce the tendency for fatigue to cause bad driving towards the end of a shift. These systems also tend to reduce wear on the whole of the transmission system and therefore they should also reduce maintenance costs. Although the greater complexity of an automatic system might make servicing more difficult, the benefits will outweigh this drawback.

Power, or power-assisted steering, if it is desirable on the heavier private cars, such as are produced in America, is even more needed on commercial vehicles, especially on those operating under conditions that call for a large amount of town work. It may be that one of the obstacles to its wider adoption is the human problem. Once a number of vehicles in a fleet are equipped with power steering, it will probably be difficult to persuade drivers to operate vehicles without it. For this reason, mechanisms that can be applied to existing vehicles, as well as to new designs, should certainly be considered.

Suspension

Suspension systems for public service vehicles, in many cases still leave much to be desired. Birmingham Midland Motor Omnibus Co. Ltd. and London Transport Executive have given a good lead in improving suspension. Other makers must follow, although not necessarily on the same lines. Many operators are now of the opinion that bus and coach suspensions should have characteristics not markedly different from those of private cars.

Some recent designs of goods carrying vehicles have shown commendable improvements in driving comfort. This trend should continue. The layout of heating and ventilating systems and controls, and the provision of the best possible facilities for all-round visibility and quick-action side window opening for hand signalling are all features that call for attention.

There are signs that the chassisless type of construction is being studied with more than passing interest by makers primarily concerned with heavy commercial vehicles. The principal object is to reduce the unladen weight of the vehicle, with a consequent increase in the pay load, without, of course, incurring any risk of fatigue failures due to wracking and vibration. Chassisless design of vehicles such as tankers and pantechnicons in the heavy category and delivery vans in the medium and lightweight class, does not present any insuperable difficulty. Whether the problems associated with chassisless design of heavy goods vehicles will ever be solved, or whether it is desirable even to attempt to solve them, is open to doubt. Nevertheless, there is a pressing need for a systematic study of the subject of frame and body deflections and vibrations.

Private cars

Except for large heavy luxury cars, there is certainly no urgent need to develop power-assisted steering systems. Nor does it seem wise to adopt automatic transmissions of the types now so widely used in America. There is, however, reason to think that a demand will arise for two-pedal control even on the cheaper cars. To meet this demand it will be necessary to develop a system that will

not add appreciably to the initial cost of the vehicle nor cause marked increase in petrol consumption.

Braking problems

Intensified work on braking systems must be high on any list of developments that ought to be pursued, although the problem of improved braking has not the same urgency here as in the United States of America. Higher cruising speeds, and every new model tends to outpace the car it replaces, inevitably mean heavier work on the braking system. Since the heat absorbed by the brakes at any stop is directly proportional to the weight of the car and the square of the speed, the problem of heat dissipation takes on ever-increasing importance.

Unfortunately, modern styling has increased the difficulties of ensuring adequate brake cooling, since the low bodies and the heavy shrouding at the front tend to restrict the flow of cool air to the brake drums. In this respect it is the luxury cars, and particularly those with automatic transmissions, that present the worst problems for the brake designer. Generally, these cars show the greatest degree of shrouding, and to make matters worse, the automatic transmission reduces the braking effect of engine over-run drag, so that there is an increase in the braking effort required at the drums.

Brake cooling

There is no immediate prospect of a solution through the development of a friction lining that will be really free from fade after exposure to high temperature. The only practical solution is to so design the car and the braking system that the drum and lining do not exceed the critical temperature. On the expensive cars ducting to ensure that a blast of cool air is directed on to the drum is worth closer consideration. There is also a possibility that the method of mounting the brakes inboard near the medial line, which has been used with some success on certain Lancia and Mercedes-Benz competition cars might be investigated with advantage.

If conventional designs are followed some degree of compromise between lining life and susceptibility to fade will be necessary. For example, on the 1954 Cadillac cars, the brake linings had a $\frac{1}{2}$ in groove cut in the periphery with good results on fade characteristics at the cost of reduced lining life. One authority states that by reducing the lining area by one-third and exposing the brake drum to cooling air, the heat dissipation is doubled.

Ease of servicing should be high on the list of priorities for cars in the lower price ranges. Generally, labour charges for servicing are now so heavy that a manufacturer who could offer a vehicle requiring only limited attention over a long period would soon find a ready market. Whether it is possible to lengthen the period between major overhauls without appreciable rise in first cost is very doubtful. There are, however, possibilities of reducing minor servicing items by increased adoption of, for example, recently developed dry-running plain bearings and self-adjusting brakes.

Plating

Almost without exception service managers agree that the most common source of complaint from car owners is the rapidity with which chromium plating becomes pitted. This trouble does not arise from lack of knowledge of the fundamentals of the plating process. Its origin is chiefly economic, since the production of better quality plating would entail a rise in costs. The possibilities of tin-nickel and tin-zinc plating processes recently developed by the Tin Research Institute might be investigated with advantage.

A second frequent cause of annoyance to the car owner is one that cannot be controlled by, but can be alleviated by, the car manufacturer. In city driving under modern traffic conditions there is always the possibility of minor damage to body panels. Although the damage may be nothing more than scratched paintwork, the cost of respraying is usually disproportionately heavy. It is not claimed that the problem is easy of solution, but there are certain possibilities that may be considered. For example, there is the possibility of using self-coloured plastics wings and door panels. Alternatively, a heavy rubbing strip of the type so popular as a styling device on most American cars might, if rubber mounted, provide a certain degree of protection. There is also much in favour of making the front wings the widest part of the body.

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LONDON TRANSPORT RM BUS

A New Chassisless, Double Deck Vehicle with Independent Front and Coil Spring Rear Suspension

AN entirely new double deck bus, called the Routemaster, has been developed to replace the existing 70-seater trolley buses at present running in the London area. The design and development have been effected by the London Transport engineers in conjunction with A.E.C. Ltd. and Park Royal Vehicles Ltd. Although the chassis of the vehicles it replaces are equipped with three axles, the new bus has only two. Moreover, despite the fact that it carries 64 seated passengers, its laden weight is less than that of the 56-seater RT bus currently in service. In fact, at the present stage of development, its all-up weight is less than 11 ton, and the dry weight unladen is 6 ton 14 cwt 2 qr. The vehicle has been tilted safely to 31 deg.

A criticism that is often levelled at large organizations is that because they have a monopoly, they are unprogressive. The critics hold that the stimulus of competition is necessary if technical progress is to be made. However, the new design that has been evolved demonstrates conclusively that at least the engineering executive and staff of the London Transport organization need no external stimulus to spur them into making technical advance.

Before the design was put in hand, a careful review was undertaken of all the fundamental operational requirements, particularly with regard to seating capacity. The next stage was to determine the best means of satisfying them. It was decided by the operating departments that the ideal vehicle to replace their trolley buses would be a 65-seater, double deck bus with an open, rear loading platform, and that the best way to satisfy this requirement was to install the engine vertically in front, alongside the cab, in the space which otherwise could not be used economically. Recent changes in the legal requirements with regard to maximum overall dimensions for a two-axle, double deck vehicle made possible a regular seating plan for 64 passengers, 36 on the top deck and 28 below; this was acceptable to the operating departments.

A large number of other factors must be considered before introducing a new vehicle in such a large organization as that of the London Transport Executive. It is only economically worthwhile to make a change if the vehicle represents a marked advance on existing designs. Moreover, this advance must be so great that the vehicle will not be outdated before the end of its useful life. The improvements that London Transport Executive insisted upon, in addition to larger capacity, include greater comfort for the passengers and crew, better stability, lighter weight, easier maintenance, simpler driving and greater economy of operation.

It is obvious that all these features could not be obtained in a vehicle of traditional design. For instance, to increase the capacity on the top deck, stiffer springs must be used in conjunction with stabilizers. To provide greater comfort, sacrifices must be made with regard either to capacity or stability. These two conflicting requirements cannot be reconciled, because maximum possible capacity is required for rush-hour services, whereas greater comfort is also necessary to attract passengers who might otherwise travel by private car during the off-peak periods. If the vehicles are not used as fully as possible in the slack periods, it means that the capital resources of the organization are not being employed to the best possible advantage to reduce costs.

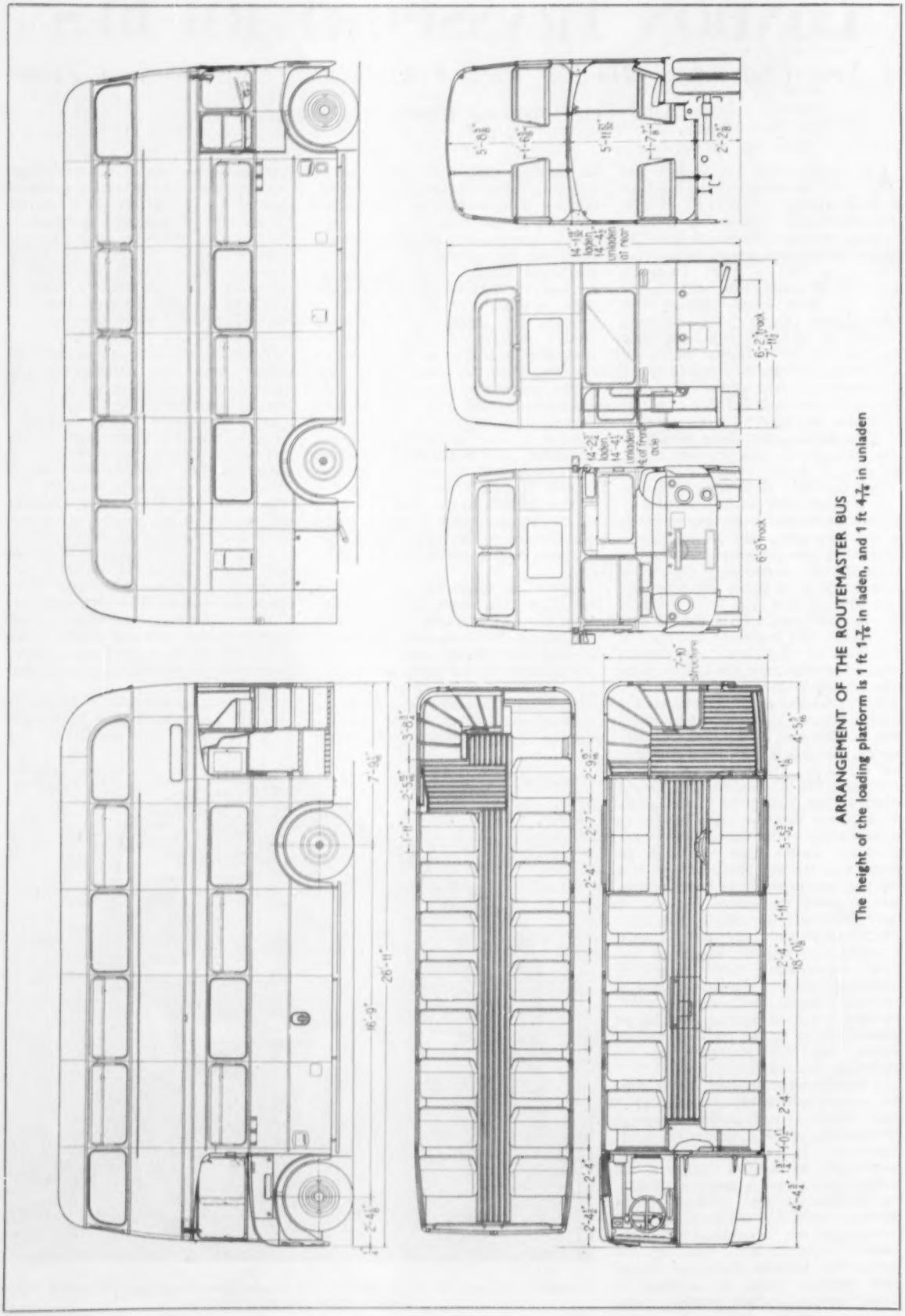
Therefore, there was no point in considering the adoption of a conventional chassis frame type of design with leaf springs and beam axle at the front. Instead coil springs have been employed both at the front and at the rear. They are set at the greatest possible distance on each side of the longitudinal centre line of the vehicle, thereby improving stability and making practicable the use of softer springs.

At the rear, the reactions transmitted through the springs are taken directly by the main longitudinal members of the structure, which are the body sides. This eliminates the need for heavy cross bearers, such as are incorporated, when the traditional form of frame is employed, to carry the loads from the body sides to the frame and thence to the suspension.

Structural efficiency and exceptional rigidity have been obtained by the adoption of chassisless, as distinct from unitary, construction. The aim has also been at eliminating the high frequency vibration experienced in chassis frames and thus reducing the possibility of fatigue failures. In this way, further reduction in the structure weight has been made possible without lowering the factor of safety. Another advantage of the elimination of the separate frame is that load and stress concentrations at, and relative movement between, the points of attachment of the body to the frame are avoided. The only functions of the underfloor framing of this vehicle are to carry the weight of the passengers in the lower saloon, and to carry some of the mechanical units and locate others.

The problems involved in the attachment of heavy units to a lightweight structure have been solved in this

Because of the adoption of the square front on the Routemaster bus, the whole of the vehicle can be cleaned by machine



ARRANGEMENT OF THE ROUTEMASTER BUS

The height of the loading platform is 1 ft $1\frac{7}{16}$ in laden, and 1 ft $4\frac{7}{16}$ in unladen

instance by mounting the engine, front suspension and steering assembly and the rear axle on sub-frames. This not only facilitates the removal of these front and rear assemblies but also makes access to and overhaul of the underside of the body structure exceptionally easy. It is thought that this feature will help a great deal in the attainment of a 20 year life without rebuild or major overhaul, since it greatly facilitates cleaning, repair and protection of this vulnerable part of the structure.

The basic conception of the structure is exceptionally sound. In fact, it is doubtful if a double deck bus that is better from this point of view has ever been produced. Experience with the RT vehicles has shown the London Transport Executive that the small additional cost involved in manufacturing a vehicle of the relatively high standard of this model is more than counterbalanced by operating cost reductions due to light weight, freedom from trouble in service and simplicity of maintenance operations.

Detail execution

Obviously the increase in seating capacity has not been obtained solely by the legally permitted increase of 1 ft in the length of the vehicle as compared with the RT type. A contributory factor is that the radiator is not in its traditional position at the front, but is installed at a small angle from the horizontal under the floor to the rear, and to the right, of the engine. This has involved the use of a ducted fan driven in tandem with the dynamo and water pump. The forward engine position has been retained because the alternatives of an underfloor engine amidships or at the rear are impracticable since one calls for an increase in floor height and the other would obstruct the loading platform.

As a result of the change in the position of the radiator and fan, the length forward of the front bulkhead has been reduced by $1\frac{1}{16}$ in. Additional length has been gained in the saloon by reducing the thickness of the front bulkhead by $\frac{1}{4}$ in, closing the distance between the front seats and the bulkhead by $\frac{1}{8}$ in and reducing by $\frac{1}{4}$ in the thickness of the squabs of all the forward facing seats. A further $\frac{3}{8}$ in has been gained by reducing the thickness of the rear bulkhead. This has made possible an increase in the length of the inward facing seats at the rear from 4 ft $3\frac{3}{4}$ in to 5 ft $5\frac{3}{4}$ in. The length of the loading platform has also been increased from 4 ft $5\frac{7}{8}$ in to 4 ft $6\frac{1}{4}$ in.

These changes have enabled four instead of three inward facing passengers to be accommodated immediately inside the entrance to the lower deck. The remaining six extra seats are on the top deck, where the additional space has been obtained by a number of detail changes: in addition to the alterations already enumerated, such as the increase in the length of the vehicle and the reduction in thickness of the seat squabs, the rake of the front and rear panels below the waist has been reduced. Thus, it has been possible to fit three more pairs of seats; the rearmost one, following the practice adopted on the RT model, is well back over the entrance to the stairs.

Weight reduction

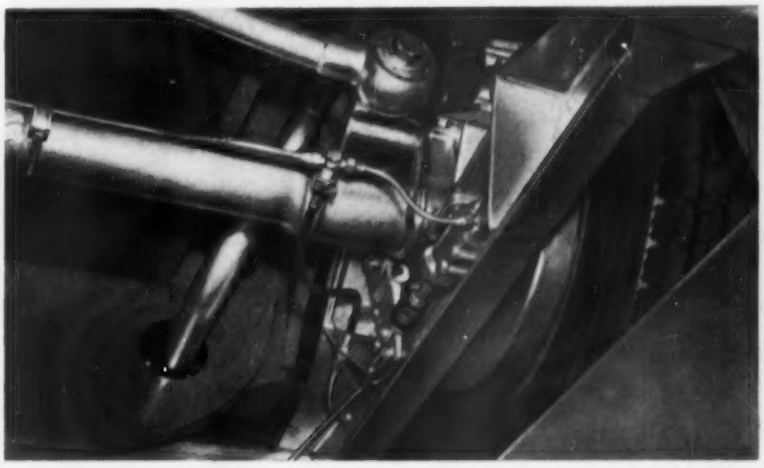
The improvements effected would normally tend to increase the weight of the vehicle and therefore its fuel consumption. However, this tendency has been offset by a number of measures designed to make more efficient use of the materials of construction and by the employment of lighter materials. Not only are most of the structural components of aluminium alloy, but also some glass fibre reinforced plastics components are used. A saving of $7\frac{1}{4}$ lb per two-passenger seat has been effected by using glass reinforced plastics seat squab boards, together with polyurethane, foamed plastics instead of rubber fillings for the cushions and squabs, and by lightening slightly the tubular frames of the seats. In addition, the front wings are of glass fibre reinforced plastics; and the bonnet lid, which weighs only $19\frac{1}{2}$ lb without hinge brackets, etc., is made of two layers of glass fibre reinforced plastics between which is a layer of rigid foamed plastics material. These innovations, of course, at present are in the experimental stage, and are subject to change as development proceeds.

A feature that has been made possible by the adoption of independent front suspension and the abandonment of the orthodox chassis frame type of design is the mounting of the engine in such a manner that it is directly supported by the exceptionally rigid main cross member that carries the suspension units. In this way, vibration that the rubber units fail to absorb completely is transmitted directly to the suspension instead of first through the side members of the frame. In designs in which the engine is mounted on the side members, the tendency is for the vibration to be transmitted through the whole of the frame and thence to the body. Moreover, the side members have to be made stronger and heavier to transmit the loads from the engine to the suspension.

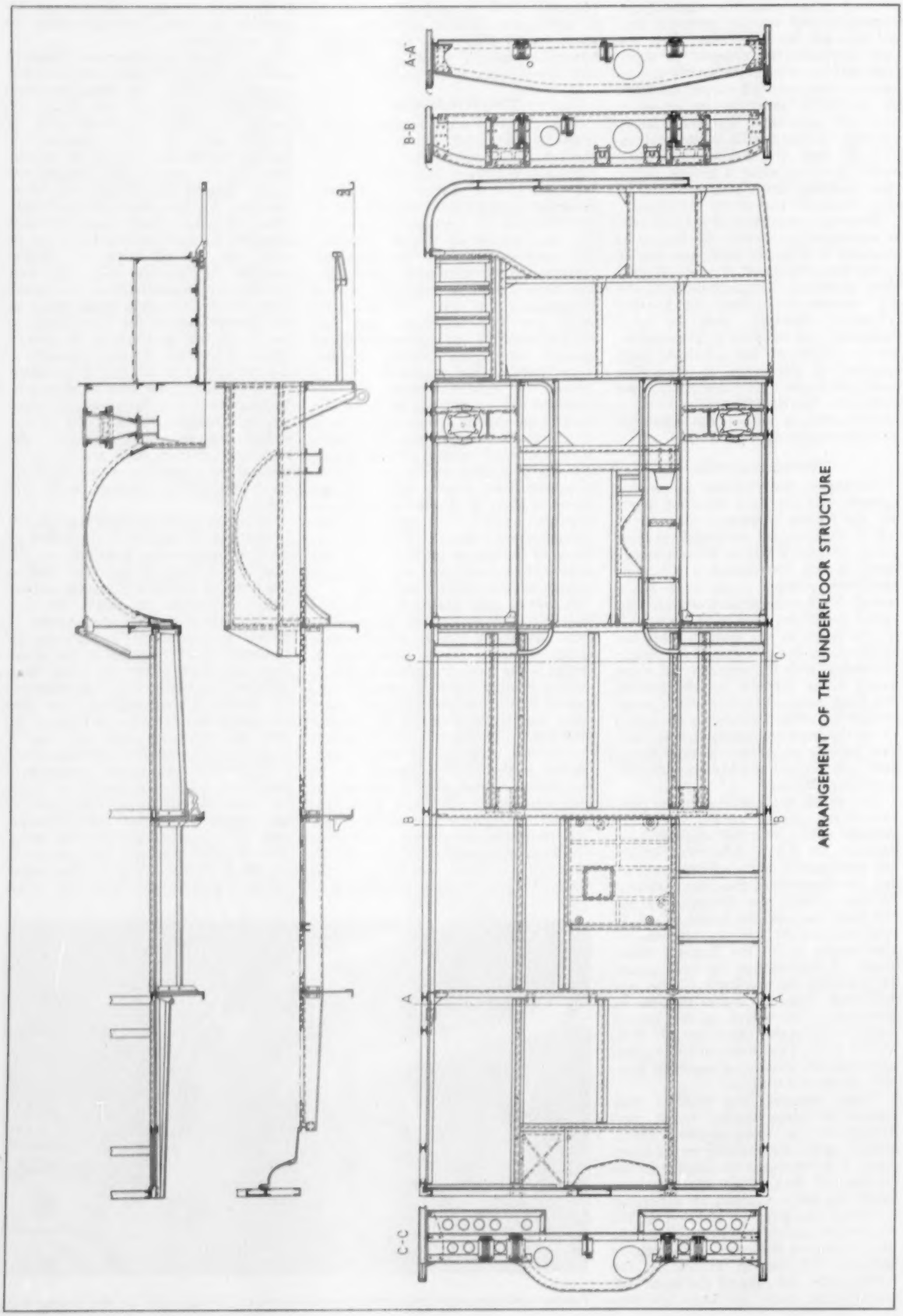
At the front, a conventional double-transverse-wishbone-link independent suspension layout has been adopted. With this arrangement, the springs are positioned further outboard than is possible with the more conventional leaf spring layouts, which, of course, have to be nearer the longitudinal centre line of the vehicle, to allow clearance for the wheels on full lock. The additional space thus obtained between the springs has been put to good use by offsetting the engine towards the nearside. Not only does this improve accessibility to the power unit, but it also gives more space in the cab and allows the hand brake to be on the left-hand side of the driver, where it does not obstruct his entry to the cab or tear his clothing as he jumps down on leaving the vehicle. Moreover, because there is no front axle, the sump can be extended to the front of the engine and, in consequence, the dip stick and oil filter tube can be incorporated in a position where they are accessible without having to lift the bonnet.

Although a through-axle is employed at the rear, its motion is controlled by a pair of long trailing links one on each side, and a Panhard rod. The trailing links extend behind the wheels and are swept outwards to carry the coil springs, which are thus spaced apart as widely as possible. To minimize the transmission of vibration to the structure and reduce the torsional loads imposed on the trailing link assembly by the axle, rubber sandwich type units are interposed between the axle casing and the transverse links and rubber bushes are employed at the link pivots.

This rear suspension arrangement has been adopted primarily to apply the loads directly to the body sides. It also improves the ride, reduces weight and, by increasing the effective spring base, enables a greater tilt angle to be obtained. Thus, despite the softer riding characteristics and the larger



Rubber sandwich type units are interposed between the rear axle and the trailing links



ARRANGEMENT OF THE UNDERFLOOR STRUCTURE

number of passengers carried on the top deck, the London Transport Executive state that the stability of the vehicle is better than has ever before been achieved.

Maintenance

As is to be expected of an organization that is primarily concerned with operation, ease of maintenance has been carefully studied. The engine, steering and front suspension are carried on the cross member of an A-frame extending forwards from the chassisless structure. This assembly can be removed easily after disconnecting the appropriate engine controls and pipes, and removing four large bolts.

The procedure is as follows. First, the weight of the vehicle is taken by slings or jacks at built-in lifting points. Then the pair of bolts, which are screwed vertically into the front bulkhead structure to pull the A-frame up to it, are removed, Next, another pair of bolts, which are passed horizontally through the rear ends of the A-frame, to secure it to the side structure adjacent to the second cross member, are loosened. The vehicle is then raised, while the A-frame pivots about the rear pair of bolts until the steering column, from which the wheel has previously been removed, is vertical. Then the rear end of the A-frame is supported and the horizontal bolts withdrawn. Finally, the body is lifted vertically until it is clear of the steering column, and a wheeled bogey is fitted to the rear end of the engine and suspension A-frame assembly, which is then rolled clear.

The removal of the rear axle and suspension assembly is a simpler operation, since there is no steering column or other obstruction to be cleared and it is not essential to fit a bogey. However, the compression in the coil springs must first be released. The suspension and engine assemblies will be interchangeable between vehicles, so that an unserviceable front or rear assembly can be replaced immediately by another one that has been serviced.

When the A-frame and rear suspension assemblies have been removed, inspection or repair of the underframe can be effected with the greatest possible ease and speed. To do this work, the body is placed on an inverter and rotated approximately 90 deg about a longitudinal axis so that all the components of the underframe are readily accessible and at a convenient height. There are many detail features that have been incorporated to facilitate maintenance; this will be apparent from the description that follows.

Underfloor structure

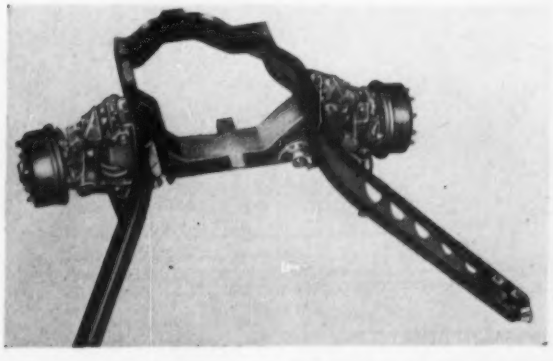
Before describing the vehicle in detail, it is necessary to emphasize that, so far, only prototypes have been built and modifications may be made in the development stage currently in progress. Basically, the vehicle structure consists of an extremely rigid box formed by the underframe, sides, roof and front and rear bulkheads. It is constructed in four bays and is fabricated from high duty aluminium alloy. The front bulkhead carries the driver's cab and the front nearside assembly comprising the wing, bonnet, front cowl, etc. At the rear, the platform and staircase assemblies are suspended from the upper saloon as in the RT bus. Attention has been paid to the need for ease of repair and replacement of front and rear ends of the body. Not only are the components mounted on the front bulkhead removable separately for replacement, but also the rear framing, the platform and the unit comprising the first four stair treads can be taken away as individual assemblies.

The principal components of the lower floor structure are transverse members. Their ends are attached at pillar stations to the body sides, which form the main longitudinal girders of the vehicle structure. This arrangement is sound in principle because there is adequate depth available at the sides to form the deep beam members needed to carry the loads over the relatively long span between the bulkheads; had the main longitudinals been in the restricted space under the floor, as with a conventional frame, they would have had to be unduly heavy. Moreover, a further saving in weight is obtained by using for this purpose the body sides, which, of course, are there in any case. There is sufficient depth under the floor to accommodate transverse members of adequate strength to carry the loads over the relatively short span between the body sides. The reason for suspending the rear platform from the upper saloon is that the body panelling below the waist on the nearside of the lower deck terminates immediately in front of the platform, whereas on the top deck the side panelling on both sides extends to the extreme rear of the vehicle.

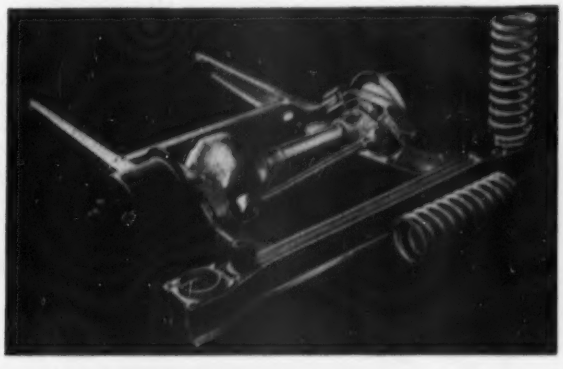
Two longitudinal members are fitted under the floor, one on each side of the gangway. Both are fitted in bay lengths between the cross members. On top of them are the top hat section rails to which the legs supporting the inner ends of the seats are secured. Extensions of these longitudinal members in the rearmost bay are formed by the inner vertical panels of the foot stools and the wheel boxes which also act as the risers for the inward facing rear seats.

The main longitudinals in the last bay but one, together with two additional members, carry the pivot brackets of the trailing links of the rear suspension and help to distribute the drag loads from them into the floor structure. The additional members are positioned a few inches outboard of the main longitudinals that support the seat rails so that, together with the floor, they form inverted channels which accommodate the trailing links when they rise to full bump position. The brackets carrying the pivots of the trailing links are bolted to the lower flanges at the front of these longitudinal members and to the vertical face of number 3 cross member. Additional longitudinal members are incorporated in some of the bays to support the edges of inspection traps, etc.

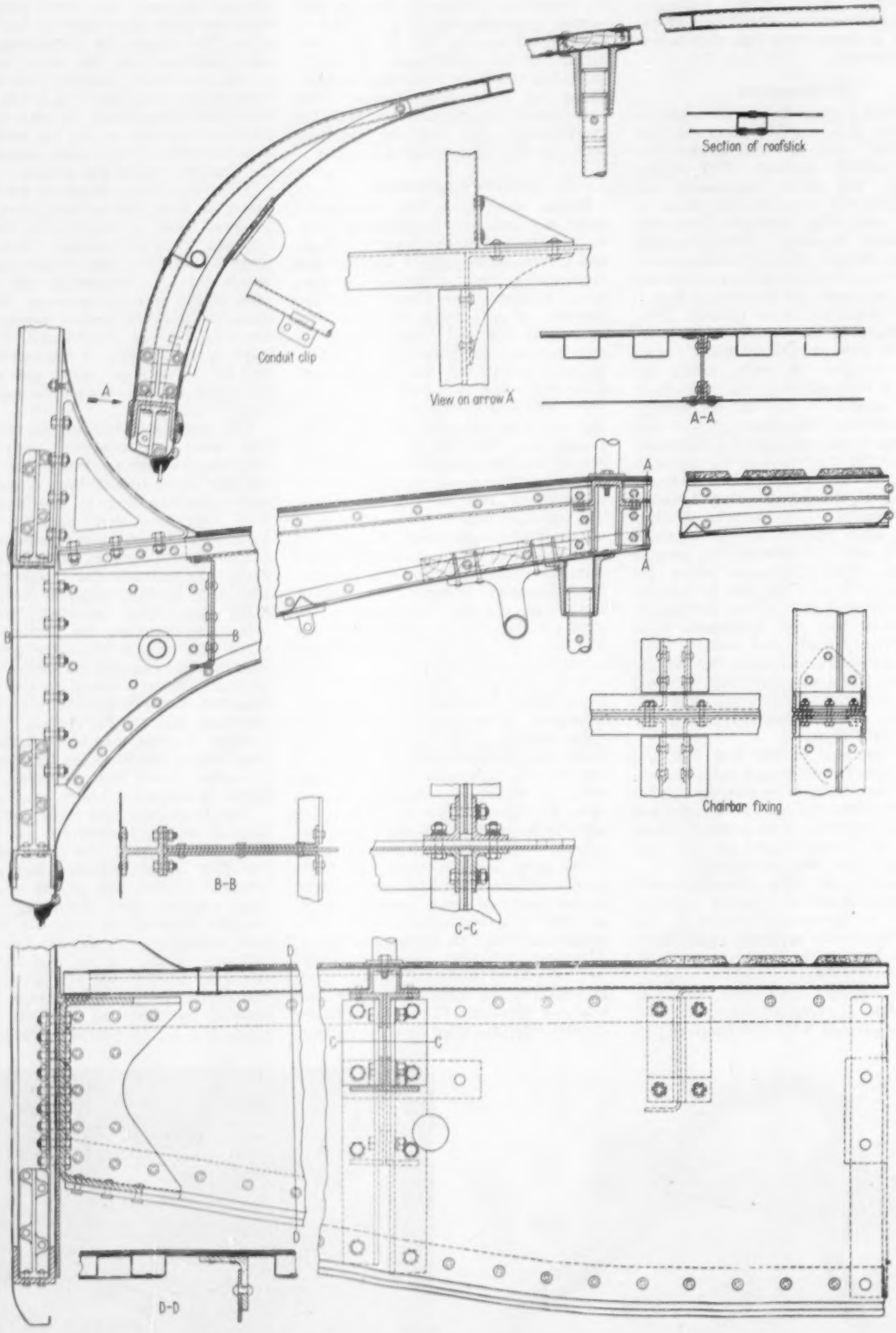
The front and rear cross members are, of course, formed by the bulkheads. At the front, the bulkhead and the first cross member behind it, number 2, form part of the structure that supports the A-frame, which extends forward to carry the engine and suspension. Malleable cast iron brackets bolted, one on each side, to the outer face of each side member of this frame are offered up to the lower ends of buttresses on the front bulkhead, and a 1 in diameter, En 16B or



A channel section A-frame carries the engine, steering and front suspension assemblies



Hollow rubber assister springs on the main cross member of the rear assembly also act as bump stops



CROSS SECTIONS OF THE ROOF, INTERMEDIATE AND LOWER FLOORS

An unusual feature of the intermediate floor is that it is in three flats

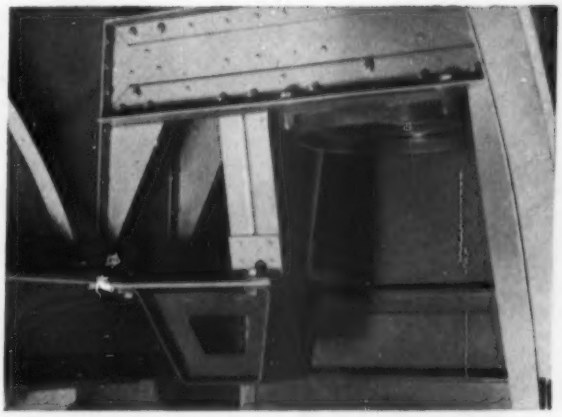
16C bolt is passed vertically through each bracket to secure the assembly to the buttress. A phosphor bronze cone is interposed between the abutting faces of each pair of brackets, which are cupped to receive it.

The tail end of each side member is attached to a $\frac{7}{16}$ in thick, mild steel bracket in the angle between the end of number 2 cross member and the side panel. This bracket is secured to the cross member by fourteen $\frac{1}{2}$ in diameter, snap head rivets, and to the vertical structure at the side by eighteen $\frac{7}{16}$ in diameter set bolts. A 1 in diameter En 16B or 16C bolt is passed transversely through the end of each side member to secure it to the bracket. Here also, phosphor bronze cones are interposed between the two components. Between the front bulkhead and number 3 cross member, the side panelling is reinforced by a 10 S.W.G. aluminium alloy flitch plate, $11\frac{1}{4}$ in deep at the centre and tapering to less than half that depth at its front and rear ends.

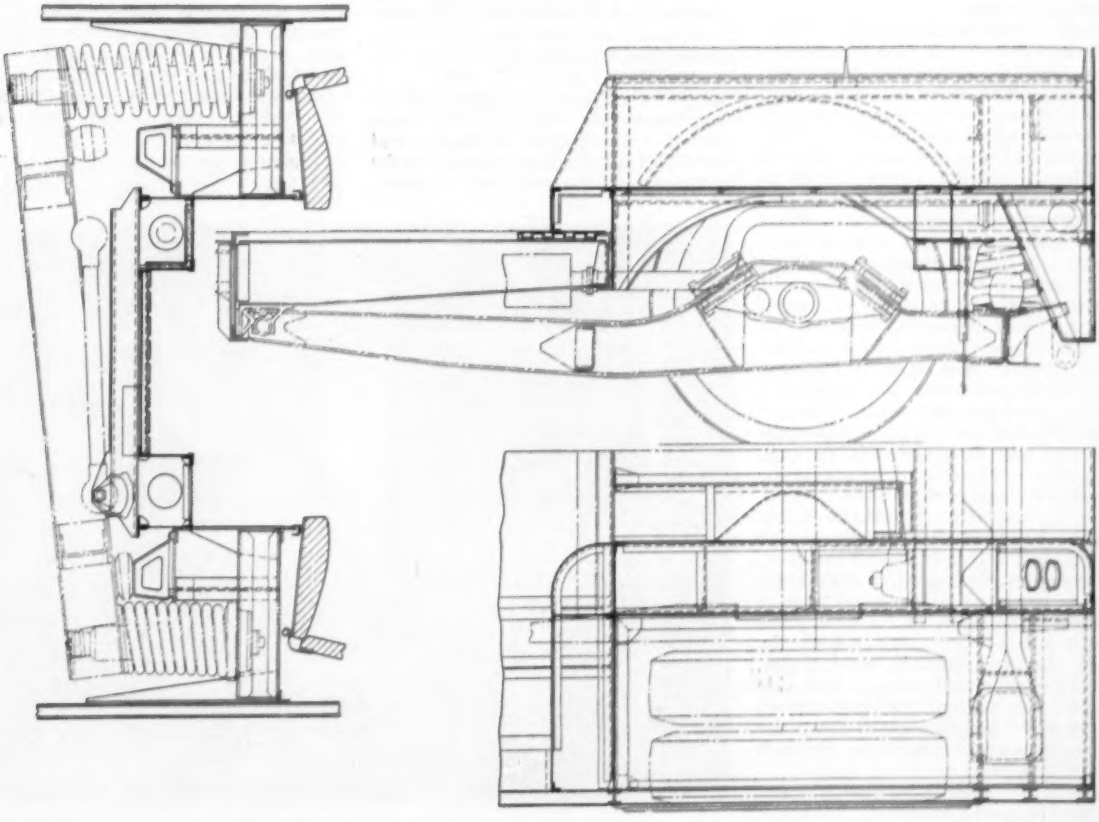
Number 2 main cross member is about $13\frac{7}{8}$ in deep at the centre and tapers to a depth of approximately $8\frac{1}{2}$ in at its outer ends. It is fabricated from two angle section HE 10 WP extrusions and a 10 S.W.G. web of HS 10 WP aluminium alloy. The extrusions form the flanges, or booms, of the section and are attached to the web by $\frac{1}{4}$ in diameter, snap head rivets at 2 in pitch. At the top of the section, the cross sectional dimensions of the boom are 2 in × 2¼ in × ¼ in, while at the bottom they are 2 in × 2 in × ¼ in.

In construction, number 3 cross member is similar to number 2, but is parallel over most of its length, only tapering outboard of the pivot brackets for the trailing links of the suspension. An angle section stiffener, or kink-strut, is fitted between the booms at the junctions between the tapered and parallel portions. Simple, ¼ in thick, HE 10 W angle brackets form the shear connections between the ends of this cross member and the side structure. Number 3 cross member takes the loads imposed on it through the trailing link pivot brackets and two of the three mounting brackets for the gearbox, in addition to a share of the weight of the passengers, etc. The gearbox is between numbers 2 and 3 cross members and its third mounting point is a bracket on the longitudinal member under the seat rail. Rubber mountings are employed at all three points to reduce the transmission of vibration.

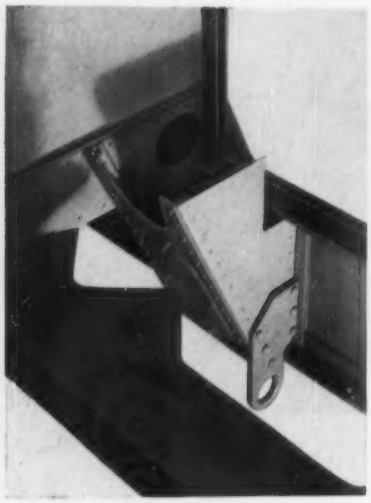
The fourth cross member takes no loads other than those imposed on it from above the floor. To clear the trailing links of the suspension, this member is cranked upwards at each end and fits into and forms part of the structure of the foot-stools. Its depth at the centre is $13\frac{1}{8}$ in and at the ends $15\frac{1}{2}$ in. The cross sectional dimensions



A view inside the wheel box, showing the structure that takes the spring and bump stop loads of the rear suspension



The cross members attached to the trailing links of the rear suspension increase the roll stiffness



The foot stool removed to disclose a buttress between the rear bulkhead and the wheel box

of the booms and webs are the same as those of the other cross members.

Wheelboxes and suspension support structure

As well as reinforcing number 4 cross member, the wheel boxes carry the structure that supports the rear suspension. Between them is a box section cross member on which is mounted one end of a Panhard rod that laterally locates the suspension system. This cross member is 3¾ in deep × 6½ in wide and is fabricated from two channel section extrusions, 3½ in deep × 1½ in wide over the flanges, with ½ in thick webs and ⅜ in thick flanges. Two 10 S.W.G. closing plates are riveted to the flanges, one on top and the other on the underside of the section.

The main components of each wheel box structure are: the vertical inner panel; a horizontal panel on top, above which are the inward facing seats; and the foot-stool. Angle section extrusions are employed to join the edges of the horizontal and vertical panels. A 1¼ in × 1¼ in × ⅜ in thick angle joins the top horizontal panel to the body side and a 2 in × 2 in × ¼ in thick angle joins the inner vertical panel to the horizontal one and also helps to carry the seat. The angle section used to attach the horizontal panel of the foot-stool to the vertical panel of the wheel box is ¾ in × ¾ in × ⅛ in thick. In the corner where the top of the foot-stool joins the riser, there is a 1 in × 1 in × ⅛ in thick angle to take the tread. At the lower edge of the riser, the edges of the floor panel seat in a 1½ in × 1½ in × ⅜ in thick angle. This, together with two more angles, riveted back-to-back one on each side at the lower edge of the vertical panel of the wheel box, carries the end of the cross member to which the Panhard rod is attached.

Inside the wheel box, there are two transverse cross members, bolted at their ends to vertical gussets flanged and riveted to the inner and outer panels of each wheel box. Four gussets are employed, two for each cross member. The cross members are spaced about 7 in apart to receive a stamped En 3A ring bolted to their lower flanges. This ring is the upper seating for the suspension spring. Each cross member comprises a 10 S.W.G., HS 10 WP web and a 2 in × 1½ in × ⅜ in thick steel angle section lower boom and a 1½ in × 1½ in × ⅜ in thick HE 10 WP angle section upper boom.

The upper end of the shock absorber is secured to a plate bolted to the seating ring for the coil spring. Two circular rubbers that form part of the end fitting of the shock absorber are fitted, one each side of the plate. Access to this end fitting is gained by removing a panel bolted over an aperture in the top of the wheel box; the shock absorber can be withdrawn vertically upwards through this aperture.

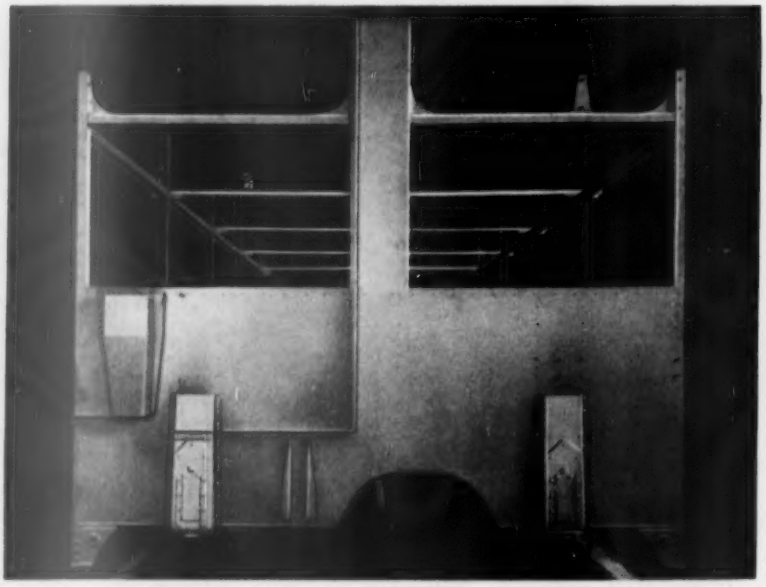
A hollow rubber unit, which is of the type described in the October 1954 issue of *Automobile Engineer*, is fitted immediately inboard of each spring. It acts as an assister spring as well as a bump stop. The rubber is mounted on the cross member fitted to the ends of the trailing links and bears on a welded mild steel bracket. This bracket, together with a horizontal plate, is bolted at one end to the base of a vertical strut riveted between the transverse members in the wheel box and at the other end to a 2 in × 2 in × ¼ in thick angle section riveted to the inner wall of the wheel box. The strut is formed by two channel sections riveted back-to-back. The sections are of 10 S.W.G., HS 10 WP with 1½ in flanges. They taper in depth towards their lower ends where 10 S.W.G. angle sections are riveted to the flanges and are drilled for the bolts that secure the bump stop and horizontal plate to them.

Under each foot-stool, a fabricated box section buttress is riveted in the angle between the inner vertical panel of the wheel box and the part of the rear bulkhead that forms the riser between the platform and the lower deck. This buttress not only acts as a gusset between these two components but also forms the stop to locate laterally the body relative to the suspension system in the event of Panhard rod breakage. Two horn-shaped brackets are riveted to the rear face of the cross member that carries the springs. They extend rearwards immediately outboard of the buttresses. Normally they are clear of the buttresses, but if the Panhard rod fails and the body moves laterally, it is stopped by one of the horns bearing against a buttress. A towing eye is bolted to the inner face of one of the buttresses.

Seat rails and flooring

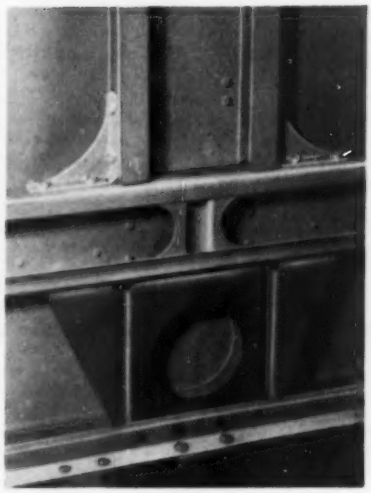
The longitudinal members under the seat rails comprise a 10 S.W.G. web with two 1⅛ in × 1⅛ in, HE 10 WP angle sections to form each boom. These angles are riveted one on each side of the top and bottom edges of the plate. In front of number 2 cross member, the longitudinals are 4 in deep; they taper to a depth of about 3 in at the extreme front end. Between numbers 2 and 3 transverse members, they are 7 in deep, while between numbers 3 and 4 they are about 8 in deep immediately above the trailing link pivot brackets and taper to about 6½ in at the rear. The longitudinals are attached at each end to the adjacent transverse members by two 1¾ in × 1½ in × ⅜ in angle section brackets, one on each side.

Inverted top hat section seat rails, ⅛ in thick × 1⅞ in deep × 2⅞ in wide



Two buttresses are assembled on the forward face of the front bulkhead so that the bolts that secure the A-frame can be fitted in an accessible position to facilitate maintenance

over the flanges, are riveted on top of the longitudinals. Seated on the flanges of the rails are the floor panels, the front and rear edges of which are carried on the transverse members. These panels are formed by a 20 S.W.G. HS 10 WP plate, with rectangular section corrugations pressed in it and an 18 S.W.G. flat sheet countersunk solid riveted on top. A 22 S.W.G. NS 4 ½H flat plate is secured by hollow rivets to the underside of each panel to facilitate cleaning. The corrugations are $\frac{7}{8}$ in deep × $1\frac{1}{8}$ in wide, and are arranged with their major axes laterally disposed so that they form beam sections, the ends of which are supported by the flanges of the seat rails and angle sections riveted to the body sides. A $\frac{1}{8}$ in thick floor covering of rubberized cork is stuck on top of the panels, except in the gangway, where $\frac{1}{16}$ in thick treads, also of rubberized cork, are stuck on the aluminium sheet.



Reinforcement at the base of the front bulkhead behind the buttress structure

Front and rear bulkheads

In general, the rear bulkhead is constructed on much the same lines as the other vertical components of the structure. The front bulkhead, because it takes the loads from the A-frame that carries the engine and front suspension, is considerably reinforced. Like the sides, it is double skinned: the outer panelling is 14 S.W.G. HS 10 WP and is solid riveted. Inside, an 18 S.W.G. sheet is solid riveted up to the level of the top of the cross member above the flywheel arch, and lapped over it is an 18 S.W.G. sheet that extends up to the waist. This sheet is punch countersunk, hollow riveted to the framing.

On each side of the bulkhead, the vertical pillars are channel sections, $1\frac{1}{4}$ in wide × $1\frac{1}{2}$ in deep × $\frac{1}{12}$ in thick, with their flanges extending outwards. Secured by solid rivets to the inner face of the rear flange of the channel is one arm of an angle section, $1\frac{1}{8}$ in × $1\frac{1}{4}$ in × $\frac{1}{4}$ in thick. The other arm of this angle is riveted in the H-section pillar at the front of the side framing.

There is another main vertical pillar in the front bulkhead frame. It is midway between the side pillars and is of C-section, $8\frac{7}{8}$ in wide × $1\frac{1}{4}$ in deep, with turned-in flanges $1\frac{1}{4}$ in wide × 12 S.W.G. The flanges are to the rear, and the pillar extends from immediately above a transverse member over the flywheel arch to the level of the top deck.

The transverse member immediately above the flywheel is also of C-section with its flanges to the rear. It is 5 in deep × $1\frac{1}{4}$ in × 12 S.W.G., with $1\frac{1}{4}$ in flanges. The waist, skirt and cant rails are of extruded channel section. All are $1\frac{1}{4}$ in wide × $1\frac{1}{2}$ in deep × $\frac{1}{12}$ in thick, except the cant rails, which are $\frac{1}{16}$ in thick. The skirt rail is continued over the flywheel arch by a $1\frac{1}{4}$ in deep × $1\frac{1}{4}$ in wide × 12 S.W.G. channel section. All the other rails extend between the side and centre pillars to which they are secured by forged angle brackets of HF 10 WP.

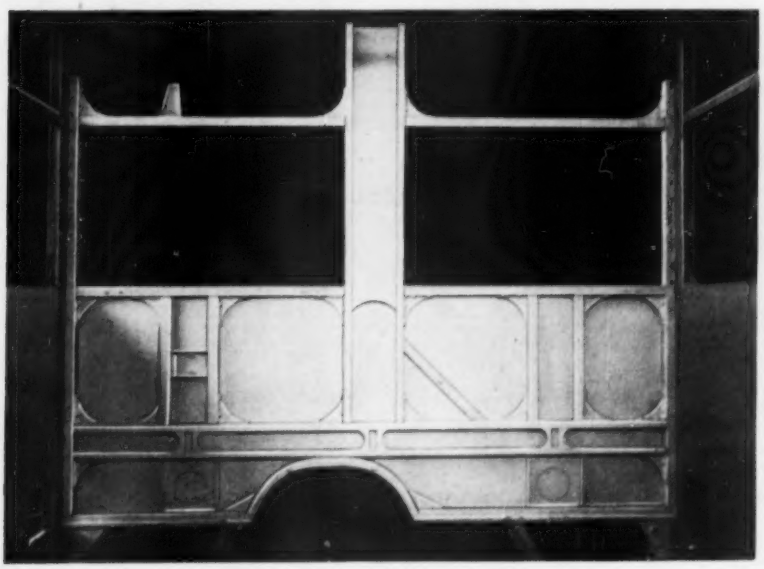
At an intermediate position between each side pillar and the centre one, the structure is reinforced to take the loads from the A-frame. For ease of servicing, the axis of the vertical bolt that secures each side member of the frame to the body structure is positioned $1\frac{1}{32}$ in in front of the bulkhead, so that it can be readily withdrawn. This has involved fitting a buttress structure to the front face of the bulkhead. It has been possible to extend this buttress only up to a point about halfway between the waist and skirt rails, so further reinforcement is provided on on the rear face of the panel.

The reinforcement is in the form of two channel section extrusions, with cross sectional dimensions the same as those of the cant rails. These channels are vertically positioned, with their flanges towards each other, between the waist rail and the transverse member above the flywheel arch. They are secured to the rails by forged angle brackets of HF 10 WP and the outer faces of each pair are $8\frac{1}{8}$ in apart. Thus, the vertical loading is transferred to the bulkhead panelling partly by the buttress and partly by these channel sections, to which the upper end of the buttress is riveted.

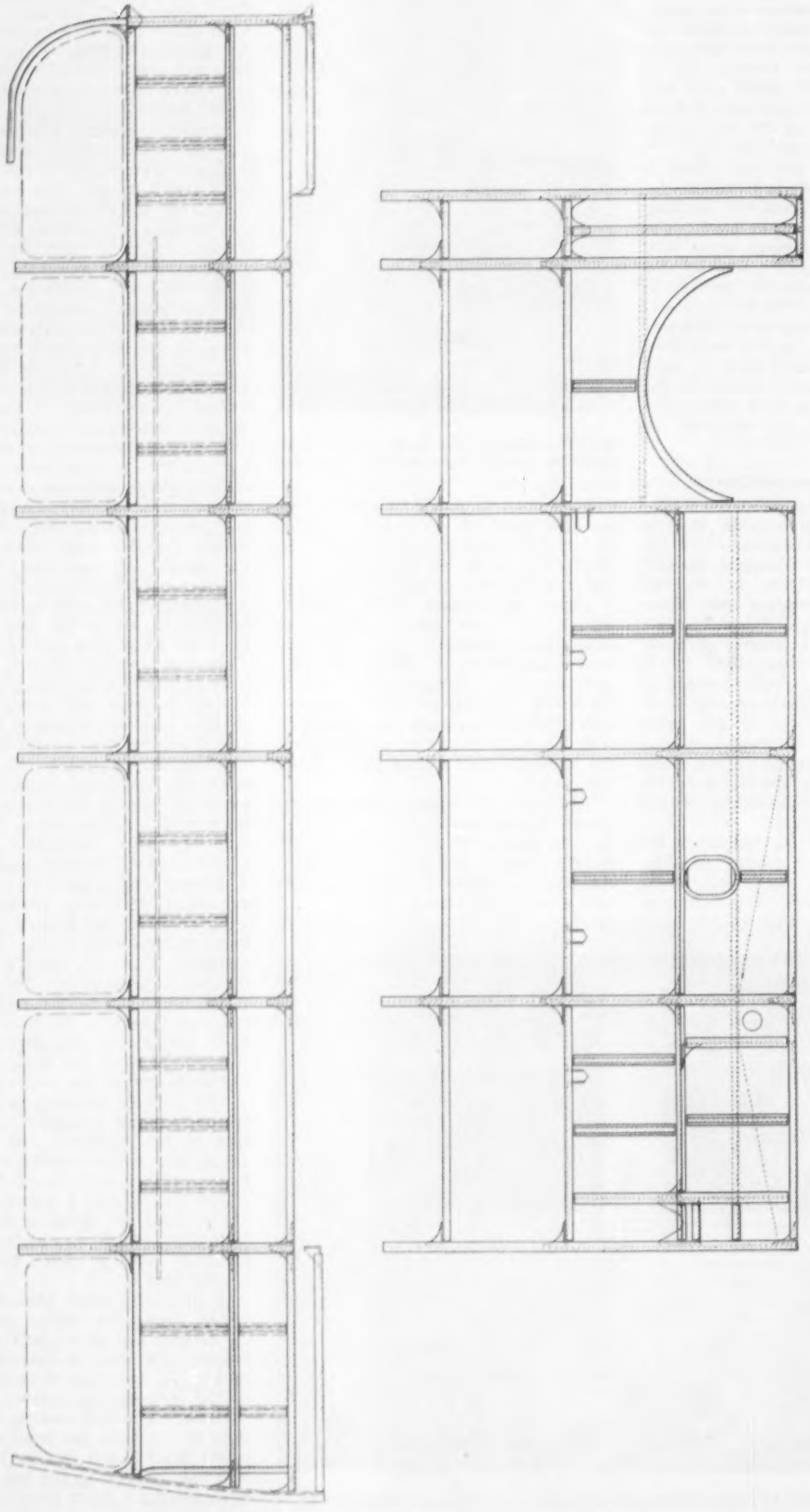
Immediately below the vertical members, additional reinforcement is provided between the skirt rail and the transverse member above the wheel arch by two vertically positioned $1\frac{1}{2}$ in × $1\frac{1}{2}$ in × $\frac{1}{16}$ in thick angle sections. A flanged plate is fitted with its flanges extending forwards between these angle sections, and flanged gussets are fitted to their outer faces. The whole assembly is riveted together except at the lower edge of the flanged plate, which is bolted to the angle section rail that supports the flooring. The main function of this assembly is to support the floor, but it also backs up the lower end of the buttress.

The buttress structure is of top hat section, riveted vertically to the front face of the bulkhead. It tapers in depth, and is fitted smaller end uppermost. The section is of 10 S.W.G., HS 10 W and for a length of about $11\frac{1}{2}$ in from its lower end it has a 14 S.W.G. doubling plate, also of HS 10 W and of top hat section, riveted over it.

A malleable cast iron bracket is bolted inside the section and also to the bottom rail of the bulkhead. This bracket takes the 1 in diameter, En 16B or En 16C bolt that pulls the bracket on the A-frame up to the base of the buttress. The bolt can be withdrawn through a hole in the front face of the upper bracket and the top hat section buttress. Access to the bolt is gained by removing a cover plate bolted over this hole. A conical seating washer of



The rear face of the front bulkhead showing the structure behind the buttresses to which is attached the A-frame that carries the engine, front suspension and steering assemblies



ARRANGEMENT OF THE SIDE FRAMING OF THE UPPER AND LOWER SALOONS

The extra pillars at the front and rear of the lower deck reinforce the structure for slinging and jacking loads while those at the rear also take the suspension loads

phosphor bronze is interposed between the bracket in the buttress and that on the A-frame.

The lower end of the bracket on the A-frame is steadied by a tie bolt arrangement. Three $\frac{3}{4}$ in diameter tie bolts are employed. Two brace the brackets on each side to gussets in the corners between the front bulkhead and the skirts of the side frames; the third is beneath the A-frame and ties the two brackets together. The cross section of the side members at the A-frame adjacent to the brackets is 9 in deep × 2½ in over the flanges × ¼ in thick.

Upper saloon floor structure

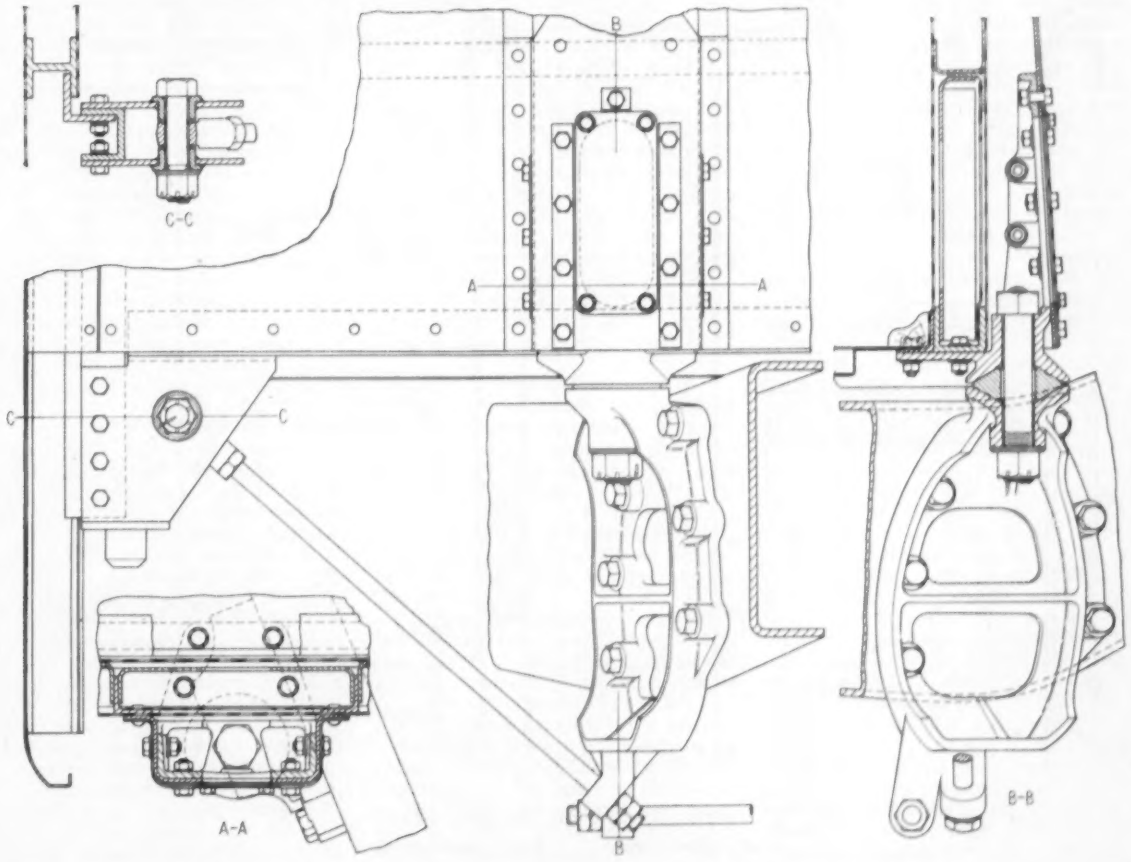
The floor structure for the upper saloon is relatively light and simple since it carries only the weight of the passengers on that deck. It comprises transverse frames vertically above those of the lower deck and four longitudinal members between the body sides. These longitudinal members are fitted between the tranverse frames. Thus, most of the load on each bay is carried initially by longitudinals, which transfer it to the transverse members and thence to the body sides.

Since space between the floor of the upper saloon and the ceiling of the lower saloon is restricted, it is not practicable to incorporate deep transverse members. Therefore, although they are similar in construction to those beneath the lower floor, their booms are formed from two angle sections, back to back, instead of one. These angle sections are ¼ in × ¼ in × ⅛ in thick HE 10 WP. They are secured on each side of the 14 S.W.G. HS 10 WP web by $\frac{7}{16}$ in diameter snap head rivets at about 2½ in pitch. At the longitudinal centre line of the vehicle, the transverse members are 1$\frac{13}{16}$ in deep, and at a point just inboard of each cove panel they are about 5$\frac{7}{16}$ in deep. Their upper edges are in three flats to carry the floor panels, and their lower ones are arched to receive the lower saloon ceiling.

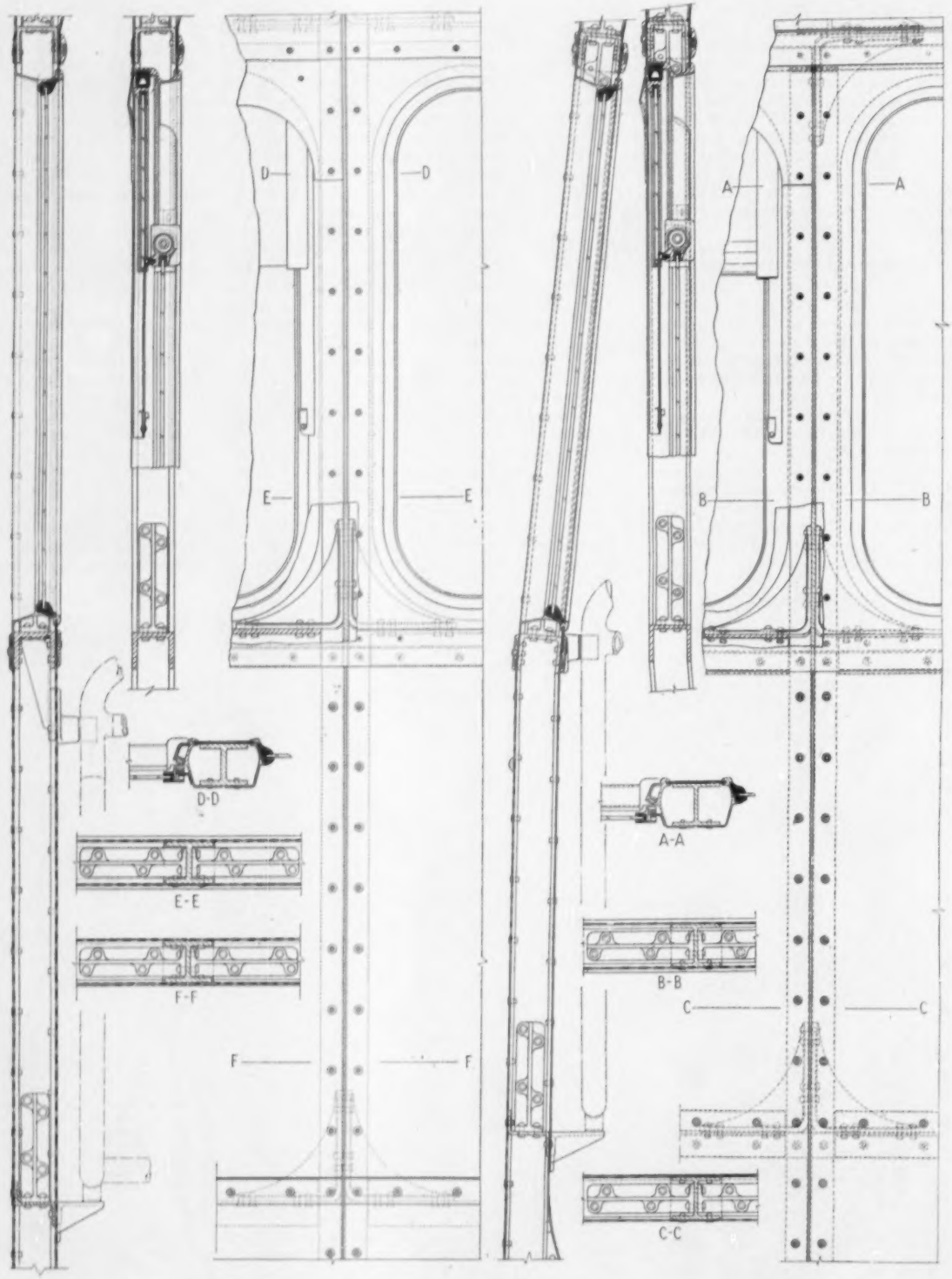
The cove panels are bent to a 9 in radius to seat on cast brackets of light alloy. They perform their usual function, in saving a certain amount of flooring, concealing the structural joints in the angle between the floor and sides, and simplifying cleaning. The brackets are secured to the flanges of the transverse members by six and to the side panels by ten ½ in diameter bolts. The foot of each bracket extends about 5½ in from the inner face of the side panelling.

Immediately below the cove panel brackets, the webs of the transverse members are each reinforced by two 10 S.W.G., HS 10 W plates, one on each side, secured by seven $\frac{7}{16}$ in diameter snap head rivets. These plates extend about 6½ in inboard from the inner faces of the pillars and are flanged at each end. At their outboard ends, the flanges are each secured by six ½ in diameter bolts to the vertical pillars in the body sides. At the inner ends of the plates, the flanges are attached by three $\frac{7}{16}$ in diameter snap head rivets to the longitudinal members that support the outer edges of the flooring.

These longitudinal members are of 10 S.W.G., HS 10 W channel section and their 1 in flanges extend outwards. They are 4½ in deep and have relatively large diameter holes punched in them for lightness. Two more longitudinal members are positioned one each side of the gangway to serve as seat rails. Each is fabricated from two top hat sections, secured together at their flanges by $\frac{7}{16}$ in diameter solid rivets and $\frac{7}{16}$ in diameter, dome head, hollow rivets, to form box sections. The overall depth of the box is about 3in, and the wall sections are ⅛ in thick except at the top, where the thickness is $\frac{7}{16}$ in. Spire nuts are fitted to the top of the section to receive the set bolts that secure the legs of the seats.



Each side member of the A-frame is secured under the front bulkhead by means of a bracket, the upper end of which is attached to a buttress structure. The lower ends of these brackets are tied together and to the lower ends of the corner pillars



CROSS SECTIONS OF THE BODY SIDES

Left : lower saloon. Right : upper saloon

At each end these longitudinal members are attached by two angle section brackets to the transverse members between the bays. Each bracket is secured to the inner face of the box section, by three $\frac{3}{16}$ in diameter snap head rivets, and to the transverse member by three $\frac{3}{16}$ in diameter bolts. Two of the bolts are passed through the angle sections and the third through the web. Distance pieces are inserted between the brackets and the web.

The centre and side floor panels seat on the flanges of the rail sections. Thus, the edges at both sides of the centre panels and the inner edge of each side panel of the floor is supported by the seat rails, while the outer edges of the side panels are carried on the channel section longitudinal members adjacent to the body sides. The floor sections are similar to those employed on the lower deck but they have no flat panels riveted to their underside. That is, they comprise 20 S.W.G., HS 10 W sheets, pressed into which are rectangular section corrugations, $\frac{7}{8}$ in deep × $1\frac{1}{4}$ in wide, and an 18 S.W.G., HS 10 W sheet countersunk solid riveted, at 5 in pitch, to the top of the corrugations.

A $\frac{1}{4}$ in thick rubberized cork floor covering is stuck on, except in the gangway, where $\frac{1}{8}$ in thick treads of the same material are employed. It is of interest to note that the floor is in three flats instead of a curved cross section, as is more usual. This arrangement has been adopted, of course, so that the corrugated floor sections of simple form may be used. The 20 S.W.G. lining panels for the ceiling of the lower saloon are secured to the lower flanges of the transverse members by moulding strips and two rows of $\frac{3}{32}$ in diameter, dome head, hollow rivets at 4 in pitch and to the seat rails by three hollow rivets per bay. Four longitudinals, in the form of flanged, inverted V sections, are spot welded to the upper face of the lining panels in such a way as to form triangular box section stiffeners.

Roof structure

The roof sticks, of rectangular section aluminium alloy tube, $1\frac{1}{2}$ in wide × $\frac{3}{8}$ in deep × $\frac{1}{16}$ in wall thickness, are fitted between the bays, and the structure is double-skinned. Adjacent to the cant rails, the cross section of the roof is thickened to stiffen the structure and to accommodate the interior lamp fittings and electrical connections. To do this, each end of the roof sticks is forked by riveting a channel section at its inner face. Thus, one arm of the fork is formed by the channel section and the other by the rectangular section tube. At the junction between the two arms, about $16\frac{1}{2}$ in from the end of the roof stick, a tubular rivet is passed through the flanges of the channel and the rectangular section tube, which at this point seats in it. At its lower end, the assembly is attached by means of four $\frac{3}{16}$ in diameter, pinned, dome head, hollow rivets to an angle bracket. Two of the rivets secure the bracket to one flange of the channel section, and the other two attach one wall of the rectangular section to the bracket.

The foot of the bracket is riveted to the top of an inverted channel section extrusion that forms the cant rail. This extrusion is $1\frac{1}{4}$ in wide × $1\frac{1}{2}$ in deep × $\frac{3}{16}$ in thick. The four $\frac{3}{16}$ in diameter snap head rivets that secure the angle bracket on top of it also retain another angle bracket, which seats below, inside the section. The downward extending arm of this lower bracket is riveted to the pillar in the side structure.

Both the inner and outer panels are of 20 S.W.G., HS 10 W. They extend between the roof sticks. The outer panels are lap-jointed and are fastened to the roof stick by a single row of $\frac{3}{16}$ in diameter dome head, hollow rivets. The inner panels are butt-jointed beneath the sticks, to which they are attached by means of two rows of $\frac{3}{32}$ in diameter dome head, hollow rivets, staggered at 4 in pitch. Four Z-section longitudinal stiffeners are spot welded to the upper surface of the inner panel. They space the two panels about $\frac{3}{4}$ in apart and are positioned $6\frac{3}{8}$ in and 2 ft 5 in on each side of the longitudinal centre line. A leather cloth chafing strip, $\frac{3}{4}$ in wide, is fitted between the exterior panel and the stiffener.

Two more longitudinal stiffeners are fitted between the roof panels, vertically above the seat rails. They are spaced 3 in apart and between them are timber blocks to which are screwed the end fittings at the top of the floating stanchions. The outboard stiffener of these two is of Z-section and is secured to the outer panel by $\frac{5}{32}$ in diameter solid rivets at 4 in pitch. Three $\frac{5}{32}$ in diameter hollow rivets per bay secure the inner panel to it. The other stiffener on each side is $\frac{3}{4}$ in × $\frac{1}{2}$ in × 20 S.W.G., HS 10 W, angle section. It is secured to the outer panel by $\frac{5}{32}$ in diameter solid rivets at 4 in pitch.

Side frames

The upper and lower saloon frames are two separate assemblies. In each, there are vertical pillars at the front and rear and between each bay. These pillars are of H-section, $1\frac{1}{4}$ in deep × 2 in over the flanges × $\frac{5}{32}$ in thick for the upper deck, but a somewhat heavier section, with the same overall dimensions but $\frac{7}{32}$ in thick, is employed for the lower saloon.

Longitudinal members are fitted between the pillars, and the waist panels are further stiffened by additional vertical members of top hat section, $2\frac{1}{4}$ in over the flanges × $1\frac{1}{2}$ in deep × 18 S.W.G.. The inner panels are secured to the flanges of the top hat sections by punch countersunk rivets; to prevent drumming, a felt strip is interposed between the sections and the outer panels. In the waist panel of the upper saloon, there are three of these vertical stiffeners in the rear and numbers 1 and 4 bays, while in the others there are two. On the bottom deck there are two stiffeners in the front bay and one in each of the others. The same number of stiffeners are fitted between the seat and skirt rails in each bay except the rear one where the space is occupied by the wheel arch.

Number 1 bay is further reinforced by another H-section pillar extending from waist to skirt, about $9\frac{1}{16}$ in behind the front pillar. Another H-section extrusion is fitted vertically between the skirt rail and the seat rail, $8\frac{1}{2}$ in in front of number 2 pillar. Thus, at the front and rear ends of number 1 bay there are, in effect, double pillars. The front one takes jacking and slinging loads, and both of them help to take the loads on that bay originating from the A-frame carrying the engine and front suspension.

At the rear, an additional pillar, number 6, is fitted behind number 5. Between them there is another H-section extrusion extending from the waist to the skirt rail. These three take jacking and slinging loads as well as those originating from the rear suspension. The front slinging points are incorporated in the driver's recessed step and a similar step on the nearside. Locating pegs for the jacks are fitted beneath the front bulkhead corner pillars. A locating bracket for the slings and pegs for the jacks are also incorporated at the rear, under the skirt rail.

At the top of the upper saloon sides, the cant rails are part of the roof structure, and the pillars are attached to them by means of angle brackets. The waist rails are of inverted channel section, $1\frac{1}{4}$ in wide × $1\frac{1}{2}$ in deep × $\frac{5}{32}$ in thick. About $20\frac{1}{4}$ in below them on each side, a Z-section extrusion, 1 in over the flanges × $1\frac{1}{4}$ in deep, is fitted between the inner and outer panels. The seats are carried on angle brackets riveted to this Z-section.

In the framing for the lower saloon, there are, in effect, two cant rails, one carrying the glazing frames and the other at the level of the floor of the upper saloon. The upper rail forms part of the framing for the panel above the lower saloon windows and provides an anchorage for the lower edge of the panelling of the upper saloon. These rails are of channel section, the one at the top being fitted with its flanges extended upwards and the lower one inverted. Both the cant rails are $1\frac{1}{4}$ in wide × $1\frac{1}{2}$ in deep × $\frac{5}{32}$ in thick.

Immediately below the lower saloon windows, there is an inverted channel section waist rail; and $23\frac{3}{8}$ in below that, there is a Z-section seat rail of the same cross sectional dimensions as that in the upper saloon framing. The cross sectional dimensions of the waist rail are the same as those of the other channel section rails, except that it is $\frac{7}{32}$ in thick. At the base of the frame is a skirt rail of the same cross section as the waist rail but its flanges extend upwards. All the longitudinal members are attached to the pillars by means of forged aluminium alloy angle brackets. Four $\frac{3}{16}$ in diameter snap head rivets secure these brackets to each component.

Both the saloons are double skinned. The outer panel of the upper framing is of 18 S.W.G. HS 10 W sheet and is a stress bearing component. The inner panel is 20 S.W.G. sheet. Between the two cant rails there is only an outer panel of 20 S.W.G. sheet. The function of the inner panel at this area is performed by the cove and ceiling panels of the intermediate floor structure. Below the lower saloon waist rail, the 16 S.W.G. stress bearing panel is riveted to the inner face of the frame where it is relatively well protected against damage. The outer panel is of 18 S.W.G. sheet. Experiments are being made with glass fibre filling between the panels of one vehicle to see what effect it has on noise.

The panel jointing is arranged as follows. At the top, the glazing frames are butted against the lower edge of the roof panel and both are riveted to the outer face of the channel section cant rail. A moulding strip conceals the joint. The lower edge of the inner panel of the roof butts against the window finisher strip, which registers in a groove in the glazing frame section, and the panel is riveted to the inner face of the cant rail. Moulding strips with plastics inserts conceal the rivets. The sides of the glazing frames are riveted to the H-section pillars.

At the waist rail of the upper saloon, both the inner and outer panels extend over the channel section. The outer one butts against the lower edge of the glazing frame and the inner one against a finisher strip, the upper edge of which registers in a groove round the glazing frame. A moulding strip conceals the inner butt-joint. At the level of the upper saloon floor, the inner panel is overlapped by the cove panel and the outer one is lapped over the upper edge of the panel between the two cant rails. This lap joint is riveted and concealed by means of a moulding strip.

Immediately above the windows of the lower saloon, the outer panel is joggled and lapped over the glazing frame, and both are riveted to the inverted channel section cant rail. The ceiling panel of the lower deck is riveted to the inner face of the rail and its lower edge butts against the window finisher strip, which registers in a groove in the glazing frame. The rivets securing the inner, ceiling panel are concealed by a moulding strip with a plastics insert. Below the waist, the panel laps over the bottom skirt panel at the seat rail and the lower edge of the outer panel is turned under the skirt rail.

All other panel jointing is effected by $\frac{5}{32}$ in or $\frac{3}{16}$ in diameter, dome head, hollow rivets, and at the inner panel joints $\frac{3}{16}$ in solid countersunk rivets are employed. The pitch is about $2\frac{1}{2}$ in throughout. Nowhere are the panels close butted, but in general a $\frac{1}{8}$ in gap is left at the vertical joints of the outside panels and a $\frac{1}{16}$ in gap between the inner panels.

Other body details

The cab is mounted on the bulkhead and can be dismantled in sections. This arrangement has been adopted to facilitate repair and replacement. Special attention has been given to the siting and disposition of the controls and instruments and switches in the driver's cab. The layout is broadly similar to that of the current London buses, but a number of new features have been introduced, mainly to ease the work of the driver.

A heater and demister unit is installed in the cab and controls are incorporated to allow cold or warmed fresh air to be supplied. As a safety precaution, a switch automatically breaks the fan circuit if the fresh air control is closed. This prevents the recirculation of already heated air within the enclosed space of the cab.

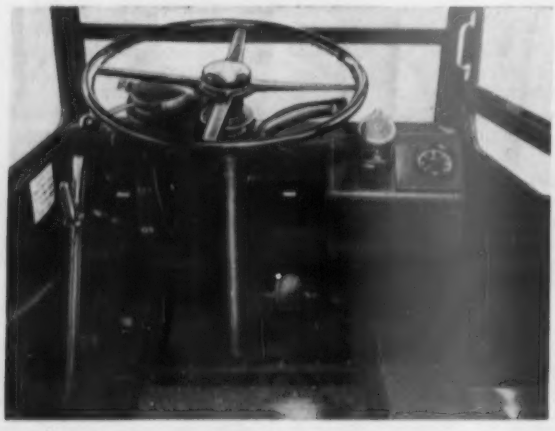
As has already been stated, the hand brake is now on the left, where it does not obstruct the door. An arm bolted to the offside of the steering column carries the horn button near the rim of the wheel, so that it can be quickly and easily operated. The accelerator and brake pedal and the aluminium floor plate are carried on the steering column, which is mounted on the A-frame. There are no obstructions on the floor except for essential controls; cleaning is therefore easy. The two-pedal control is a good feature, not only because it eases the work of the driver, but also because it reduces wear and tear on the transmission in the event of its being subjected to bad driving. Moreover, it increases the speed of get-away from stops. This is a most important feature for operation during periods of peak traffic.

The head lamp switch is now adjacent to the windscreen wiper switch which, together with most of the other auxiliary controls, have been grouped on a facia. A foot-operated dip switch is employed. Fitted to the light, aluminium-skinned, ply door is a spring assisted, vertically sliding window, which is quick acting to facilitate hand signalling.

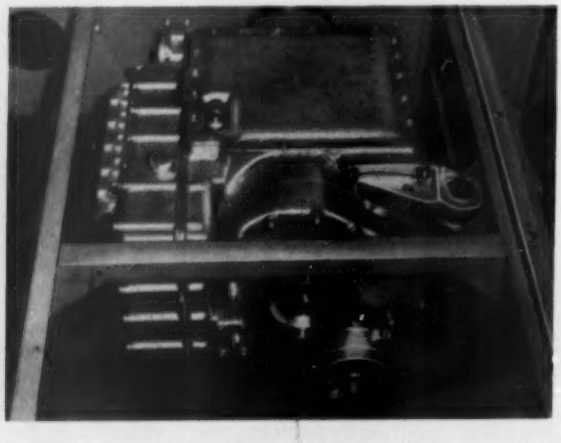
The top and bottom windscreens are of the winder-operated type, similar to those in the vehicles currently in service. An example of how maintenance work has been made easier in the RM vehicle is the adoption of the square front and the pivoting of the rear view mirrors and direction indicators so that they can be hinged back while the vehicle is cleaned. With this arrangement all cleaning can be done by machine. The front ends of the earlier designs had to be washed with hand appliances. The elimination of this work is a particularly important feature, since much of the cleaning is done late at night and, of course, is most arduous during the cold winter months.

On the nearside at the front, the bonnet top is of the spring balanced type. The front nearside wing is flexibly mounted, by means of rubber bushes, on the bulkhead and A-frame. It houses the radiator header tank, which is also mounted on the bulkhead. Wing valances of glass fibre reinforced plastics are employed. The front grille and panelling are of sheet aluminium. In the panelling is a small hinged flap for access to the oil filler, dip stick and fuel cock. The central panel at the front and a section of the nearside wing are removable for access to the engine.

At first sight, accessibility to the oil



In the cab, the hand brake is on the left-hand side, where it is clear of the door



A view of the gearbox installation, showing one of the three rubber mountings

filler and dipstick may appear to be a minor feature but, in fact, is not. This is because of the frequency with which access is required to these points. Moreover, topping up with oil is mostly done late at night and in many cases by men who are not physically fit enough for more active duties, such as those of conductors. In these circumstances, if the operation involves climbing over the wing and reaching down into a dark and relatively ineccessible part of the engine compartment, there is a tendency to skip it, or at least not to perform the operation properly. Indeed, the psychological aspects of maintenance need to be studied as carefully as the physical ones. The simplification of the operation is also in conformity with the London Transport Executive's general policy of making the maintenance work easier and more attractive.

Beneath the stairs there is sufficient room for the conductor to stand comfortably, leaving ample space for the passengers to pass in and out unobstructed. The fare-table forms the door of the conductor's locker, which is at shoulder height beneath the stairs. Luggage space is provided on top of the battery compartment, which is also beneath the stairs.

The main saloon windows are inside-rubber-glazed in their aluminium alloy frames, or pans, which have polished interior rims. There are four opening side-windows in the lower saloon and six in the upper one. They are of the aluminium alloy framed, high level winder type without a bottom rail on the opening portion. This facilitates cleaning and minimizes obstruction in the line of vision of seated passengers. The forward facing windows on the top deck and the bulkhead window on the nearside of the lower deck normally can be opened, but are provided with a locking mechanism to prevent opening in cold weather. Two of the fixed glasses in each saloon are of the breakable type for use as emergency exits. An alloy frame of pressed sections, fitted with curved, toughened glass, forms the energency exit at the rear of the upper deck. Two, slot type adjustable air intake vents are incorporated in the front framing on each saloon and are controlled by the conductor.

Externally, the traditional livery of red with a cream band at the level of the upper deck floor is retained, but the interior colour scheme is a departure from current practice. The seat and squab trimming is in moquette with damask red hide ends, and Chinese-green leather cloth covers the squab backs. The saloon interior colour is damask red and the ceiling panels are of sung yellow. A polished alloy moulding with a white plastics insert separates the two colours. The platform and staircase stanchions and handrails, together with their brackets and fittings, are of stainless steel, while those in both saloons are of polished alloy.

The four 6 V batteries under the stairs are carried in a light alloy cradle. They can be removed from the outside through a quickly detachable panel retained by captive bolts, but access for topping up is gained through a hinged flap under the stairs. Winking direction indicators of arrow form are fitted at cant rail level at the front of the body. They operate in conjunction with similar indicators at waist level in the rear panels. An illuminated number plate and stop lamp assembly is mounted below the waist at the rear. Combined reflectors and rear lamps are fitted at each side, the nearside unit forming the lower brackets of the rear-end handrail. This arrangement may be altered slightly because of an amendment to the Regulations, which now allow the rear lamp to be re-positioned on the rear end panel. The saloon lamps are similar to those in the single-deck buses and Green Line coaches described in the December 1951 issue of *Automobile Engineer*. The usual lamp equipment is provided at the front of the vehicle. In the interests of weight-saving, the cores of the cables and the conduits are of aluminium.

(To be continued)

INSTITUTION OF MECHANICAL ENGINEERS

Forthcoming Meetings of the Automobile Division

The following meetings will be held during January:—

DERBY CENTRE

Monday, 31st January, 7.15 p.m., in the Midland Hotel. Paper: "Rocket Propulsion," by Professor A. D. Baxter, M.Eng., M.I.Mech.E.

NORTH-EASTERN CENTRE

Wednesday, 19th January, 7.15 p.m., in the Chemistry Lecture Theatre, The University, Leeds. Paper: "The Skid-resisting Properties of Tyres and Road Surfaces," by G. Grime, M.Sc., and C. G. Giles, B.Sc., and "Investigations into the Braking Performance of Road Vehicles," by H. J. H. Starks, Ph.D., and R. D. Lister, A.M.I.Mech.E.

NORTH-WESTERN CENTRE

Tuesday, 25th January, 7.15 p.m. (previously announced for Thursday, 20th January), in the University of Liverpool, Walker Buildings. Paper: "Recent Developments in the Road Transport and Handling of Bulk Sugar," by C. H. Williams, A.M.I.Mech.E.

SCOTTISH CENTRE

Monday, 17th January, 7.30 p.m., in the Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow. Paper: "The Running-in of Engines: Choice of Cylinder Bore Finish," by K. R. Williams and S. G. Daniel.

WESTERN CENTRE

Thursday, 27th January, 6.45 p.m., in the Royal Hotel, Bristol. Paper: "Production in Commercial Vehicle Manufacture Caused by New Models," by D. L. Campbell, B.Sc., A.M.I.Mech.E.

The following meetings will be held during February:—

BIRMINGHAM CENTRE

Tuesday, 22nd February, 6.45 p.m., in the James Watt Memorial Institute, Great Charles Street. Address by the Chairman of the Automobile Division, J. H. Pitchford, M.A., M.I.Mech.E., entitled "Engine Research and Development as a Service to Industry: A Personal Experience."

COVENTRY CENTRE

Tuesday, 1st February, 7.15 p.m., in the Craven Arms, High Street. Paper: "Some Notes on Carburation and Allied Problems," by C. H. Fisher.

LUTON CENTRE

Monday, 14th February, 7.30 p.m., in the Assembly Room, Luton Town Hall. Paper: "Analysis and Interpretation of Service Records," by A. T. Wilford.

DERBY CENTRE

Monday, 28th February, 7.15 p.m., in the Midland Hotel. Paper: "Helicopters," by Mr. Hollis-Williams.

NORTH-EASTERN CENTRE

Wednesday, 16th February, 7.15 p.m., in the Chemistry Lecture Theatre, The University, Leeds. Address by the Chairman of the Automobile Division, J. H. Pitchford, M.A., M.I.Mech.E., entitled "Engine Research and Development as a Service to Industry: A Personal Experience."

NORTH-WESTERN CENTRE

Thursday, 17th February, 6.45 p.m., in the Engineers' Club, Manchester. Joint Meeting with the North-Western Branch. Papers: "An Investigation into the Effect of Fuel Addition to Intake Air on the Performance of a Compression Ignition Engine," by W. T. Lyn, M.Sc.(Eng.), A.M.I.Mech.E., and "The Effect of Auxiliary Fuels on the Smoke Limited Power Output of Diesel Engines," by D. L. Derry, A.M.I.Mech.E., E. M. Dodds, M.A., D.Sc., M.I.Mech.E., E. B. Evans, Ph.D., M.Sc., and D Royle, B.Sc.(Eng.).

SCOTTISH CENTRE

Monday, 21st February, 7.30 p.m., in the Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow. Paper: "Some Problems in Lubrication and the Substances called Additives."

WESTERN CENTRE

Thursday, 24th February, 6.45 p.m., in the Royal Hotel, Bristol. Paper: "The Jaguar Engine," by W. M. Heynes.

ELECTROSTATIC BODY SPRAYING

Fully-automatic Plant Employed by the Studebaker Corporation

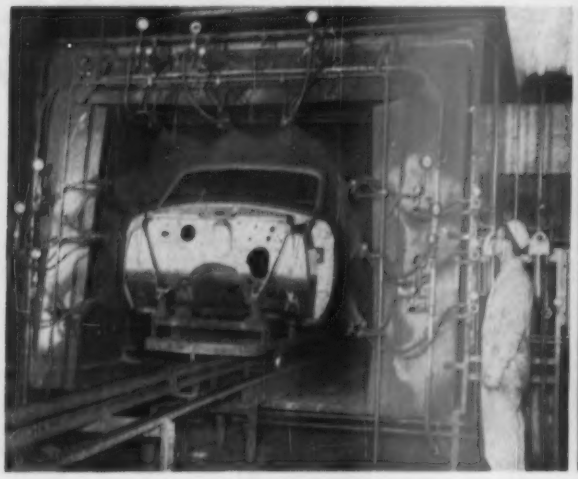
RECENTLY the Studebaker Corporation of the United States of America have introduced automatic electrostatic spraying into their painting and finishing schedule for car bodies. For this purpose they employ Ransburg spray booths to apply a thick and enduring primer-surface undercoat to the car body. It is claimed that the resultant product has greatly improved resistance to adverse weather conditions, climatic irregularities and prolonged exposure to the sun.

For the application of the primer-surface undercoat, the bodies pass through three spray booths in series, but only two of the booths are of the electrostatic type. Nine powerful spray guns are mounted at each end of each electrostatic spray booth. The electrode wires are placed inside the booth near the entrance and the exit. They are charged at 90,000 volts. This creates the necessary electrostatic fields to charge the particles of paint spray to cause them to be attracted to the metal surfaces that are to be painted. In passing through the booths and the electrostatic fields, the body receives a very even coat. Apart from the question of quality, this system has economic advantages, since there is practically no overspray and the amount of paint used for a given output is very greatly reduced.

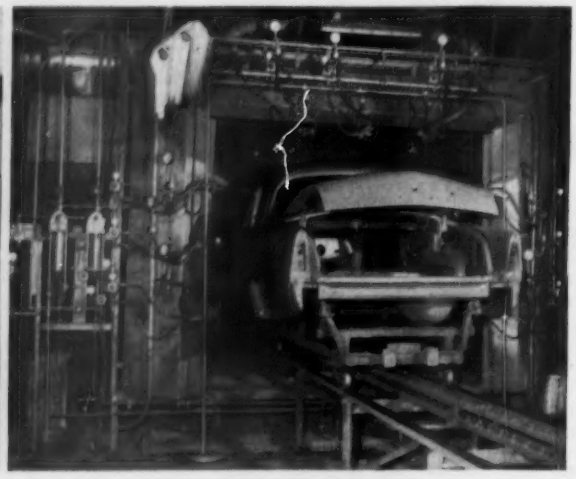
The car bodies are mounted on specially constructed dollies, which are advanced by a floor level chain conveyor. As the dollies move along on the conveyor they actuate limit switches that automatically turn the spray guns on and off. The guns can operate only when the surfaces to be sprayed are in the correct position. Normally, the space between one body and the next is only a few feet, but at regular intervals the gap is increased to give the operators an opportunity to clean the nozzles of the guns, adjust gun positions if necessary, and to clean the electrodes.

A Dupont oil base primer-surfacer is used at a spraying pressure of 15-18 lb/in^2. The viscosity applied is 13 as measured by a No. 7 Ford cup. The thickness applied is such that although 60 per cent is removed by water sanding, sufficient remains to be adequate for the proper life of the finish.

Though time and space are allowed for gun adjustment and cleaning, normally about 90 car body shells pass through the booths in an hour. In the third, the non-electrostatic, booth, the body interiors and the rear deck are hand-sprayed with primer-surfacer.



Body emerging from electrostatic booth



Entrance to second electrostatic booth

CORRESPONDENCE

STRAP DRIVE CLUTCH

SIR,—In your comprehensive and most interesting November review of the exhibits at the last Commercial Vehicle Show, I note that you refer to the strap drive clutch as having been introduced by Messrs. Borg and Beck Co. Ltd.

The origin of this type of clutch is, I believe, my own invention.

Like many simple ideas this one has had a prolonged struggle to achieve recognition and wide application.

I first designed this device for an experimental Sunbeam car in the early twenties but it was not until I created the 14/45 Talbot in 1926 that it came into public use.

This clutch subsequently equipped the model 90 Talbot, which in the 1930 Le Mans race revealed itself as the first silent sports car in the world as well as the most efficient standard automobile at the time.

GEORGES ROESCH,
M.I.Mech.E., M.S.I.A., M.S.A.E.

VALVE AND SEAT ANGLES

SIR,—I have read with a great deal of interest in the *Automobile Engineer*, September 1954, the article "Poppet Valves, Guides and Seats" and should like to make the following comments:

Under "Detail design" reference is made to 30 deg angle seats. In Table III the included angle of these seats is given variously as 58, 59 and 60 deg. In Fig. 4 is drawn the section of valve and seat showing the seat with an included angle of 91 deg. If the valve angle is carried progressively to the so-called 30 deg angle, it would give an included angle of 120 deg. Draw your own conclusions.

As diesel instructor at the Province of Ontario's Provincial Institute of Trades I have always pointed out the inconsistency of the 30 deg definition in order to help the students avoid confusion when refacing valves on standard machine tools. I think the person, if he can be found, who started this 30 deg misnomer should be brought to task and made to apologize for his mistake and we engineers should hide our heads in shame for perpetuating it.

A. W. FRAZER, M.S.A.E.

NEW PLANT AND TOOLS

Recent Developments in Production Equipment

A RELIABLE master layout is a basic necessity for the inspection of forms by projection. A recent development by the Aldridge Tool and Engineering Co. Ltd. will, therefore, be of interest to many inspection departments, since it simplifies and speeds up the production of accurate projection layouts. The unit, which is shown in Fig. 1, is essentially a precision marking-out fixture. It can be operated by one person, who need only have an elementary knowledge of trigonometry and the ability to use a vernier height gauge and a vernier protractor.

The fixture is of robust construction and carries a protractor head that can be rotated through 360 deg. A spring-loaded plunger accurately locates the head at 15 deg intervals, and an angular vernier, graduated in minutes, is used for setting the head at any desired angle. A rectangular sheet of Perspex is clamped firmly to the head by means of an easily removable metal frame. On the standard layout fixture, the sheet of Perspex forms a screen of the same size as the screen of the Hilger projector; the fixture can be supplied with other sizes of screen if required.

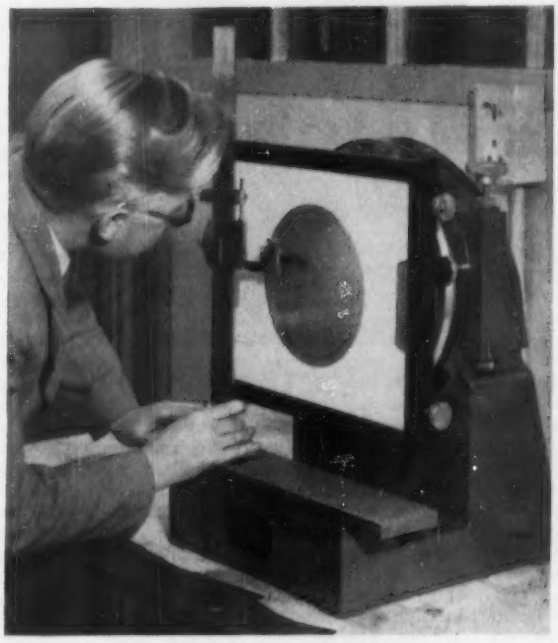


Fig. 1. Aldridge layout fixture
Alfred Herbert Ltd.

This new and rapid system of layout production is based on simple and graphical solution of the required form, which is then used in the fixture to produce the final layout through the medium of an ordinary vernier height gauge. In preparing a layout, the component dimensions are first multiplied by the magnification constant. The approximate outline of the magnified form is then sketched out on a sheet of graph paper, with pencilled notes to indicate the relative positions of the various planes and radii. The metal frame is removed from the fixture and a sheet of the recommended layout material is placed on the Perspex screen, and when smoothed over with a brush or cloth it will adhere to the Perspex. The graph paper is placed behind the screen and the metal frame refitted. It is then a simple matter to build up the magnified form from the notes made on the graph paper by using a vernier height gauge, in conjunction with the protractor head, to scribe the outline into the surface of the layout material. To complete the layout, the radii are added and a little micrometer blue is rubbed into the grooves.

Layouts produced in this manner are a permanent record and may be stored in an even temperature for long periods without any loss of accuracy. The recommended layout material is manufactured by a specialist firm. It is translucent, light diffusing and sufficiently durable to withstand the treatment of everyday shop use. Alfred Herbert Ltd., Coventry, are the sole agents for this device.

Powered tracer machine

Various Giddings and Lewis milling machines are now available with British

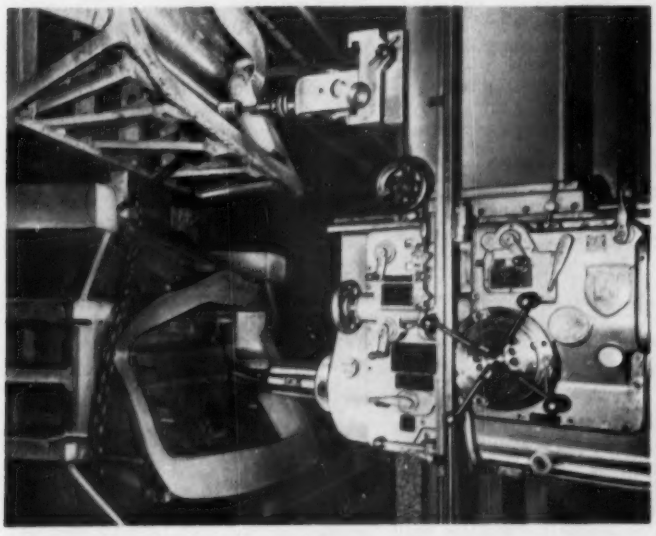


Fig. 2. Giddings and Lewis milling machine with BTH electronic control
Rockwell Machine Tool Company Ltd.

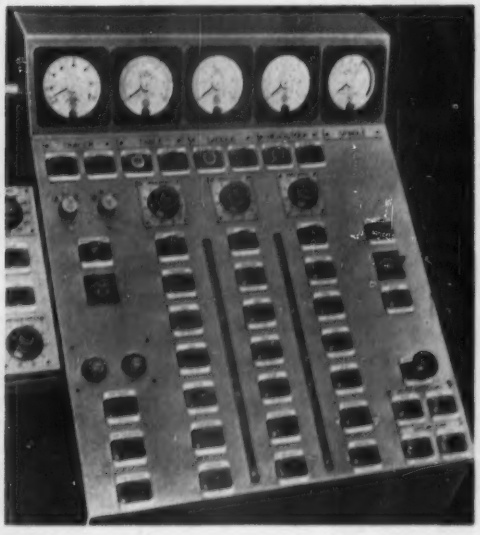


Fig. 3. The control panel for the BTH 3D tracer system

Thomson-Houston electronic control. They are not only high precision, high powered milling, boring and drilling machines, but are also most versatile duplicating machines, capable of carrying out all operations for die milling and 360 deg profiling work. The BTH 3D tracer equipment can be supplied with 4 in and 5 in table type machines and both table and floor type 6 in and 7 in machines.

As the tracing system is of the stepless type, good performance is obtained on both gentle and rapidly changing contours. The success of the Giddings and Lewis 3D tracer machines is due to the combination of the ample power and rigidity of the basic machine and the high sensitivity of the BTH tracer control. Not only are extremely high feed rates practicable, but it is also possible and economical to use small "pick" feeds.

The BTH 3D system gives simultaneous automatic control of the saddle and headstock or saddle and table for die milling work; alternatively the table and headstock may be automatically controlled to give 360 deg profiling. A single tracing head, which is sensitive to deflections in all three axes, is used for tracing work. The three feed motions are driven by large horsepower D.C. motors, each of which is powered by its own D.C. generator on the Ward-Leonard principle.

These generators are regulated by an electronic control which receives its signals from the tracing head. The signals are developed in variable inductance coil units, which once set do not require adjustment or maintenance. Variation of the individual feed rates is effected entirely by varying the speeds of the D.C. motors. This gives the simplest possible mechanical transmission that requires the minimum of maintenance. The feed range is covered by two gear ratios selected by push buttons. There is also push button control for the rapid traverse, 120 in per minute, for all three feed motions.

In die milling, see Fig. 2, the stepless feed over the surface of the work remains constant irrespective of the steepness, which may even include undercuts. This class of work is normally carried out in a series of horizontal and/or vertical passes. Adjustable limit switches fitted to the machine automatically reverse the feed at the end of a pass and simultaneously set the next cut. The direction of tracing is shown by one of two light-indicator push buttons. Operation of the unlit button anticipates the operation of the limit switch. In low gear, the feed rate can be varied from 0·4 in to 5·0 in, and in high gear from 4·0 in to 40 in per minute. The feed rate in either range can be varied while the machine is cutting. The machine cycle for 360 deg profiling of both external and internal forms is completely automatic.

Fig. 4. Rackfeed pneumatic drill
Desoutter Brothers Ltd.

Fig. 3 shows the complete BTH 3D control panel. An unusual feature of this control is the "steering" system. When this is put into action, a single rotary portable device controls the two motions which are to be on automatic control in such a manner that the nett motion of the stylus relative to the model lies at an angle corresponding to the direction indicated by an arrow engraved on the rotary control knob. This feature greatly simplifies the control of the machine when the tracing head is being set in contact with the model. It can also be used for roughing cuts and for facing irregular outlines with a facing cutter.

Several protective features are incorporated in the design. The principal are:—

(1) Over or under deflection of the stylus tip causes the immediate stopping of all three feed motions.

(2) Over-travel limit switches are fitted to all three feed motions. When normal milling feeds are used, operation of an over-travel limit switch will stop only that feed motion, but when steering or tracing, the operation of any limit switch stops all feed motions.

(3) All motions have thermal overload protections. In addition, a magnetic overload instantaneously stops the feed motions if the spindle is being overloaded.

The Rockwell Machine Tool Co. Ltd., Welsh Harp, Edgware Road, London, N.W.2, are the agents for these machines.

Rackfeed drill

Although designed primarily to meet the needs of aircraft producers, the Rackfeed drill, see Fig. 4, recently developed by Desoutter Brothers Ltd., The Hyde, Hendon, London, N.W.9, will be of interest to many organizations connected with the automobile industry. This tool has a geared hand feed and also carries its own bayonet jig fitting. The method of operation is simple. First, the tool is applied to the jig, the nose is pushed home into the jig bush, the tool is given a quarter turn and the bayonet fitting slides under the heads of the bayonet collars. The handle is then rotated. This advances the machine through a reduction gear unit, and when the twist drill approaches the metal, the air is automatically switched on by a cam. When the hole is drilled, the handle is reversed, the machine retracts and the motor switches off.

With this new tool, drilling operations can be speeded up, because the operator can apply a greater load with less effort. Furthermore, the bayonet fitting ensures correct positioning and alignment. The tool is available in five sizes ranging from one running at 3,300 r.p.m. with a capacity of $\frac{1}{8}$ in, to one running at 350 r.p.m. with a capacity of $\frac{1}{2}$ in. Normally, these drills are supplied with a $2\frac{1}{2}$ in stroke, but they can be provided with longer stroke if necessary.

WELDING EQUIPMENT

SECTION 1, Metal Arc Welding Electrodes, of the Directory of Welding and Fabricating Equipment, has been published by The Louis Cassier Co. Ltd., Dorset House, Stamford St., London, S.E.1. It is the first comprehensive guide to the full range of electrodes now available in the United Kingdom, and engineers may now see at a glance details of every British electrode for welding any of the metals now used in the fabricating industries. This new and invaluable reference work is published at 3s. 6d. (by post 3s. 9d.).

The Directory is divided into five parts, dealing with electrodes for arc welding mild steel, alloy steels, cast iron, and non-ferrous metals, and for hard facing. Electrodes are grouped under the names of the respective manufacturers. The main details, together with any special details, are given for each electrode. Recommended welding positions are given for each electrode, and the British Standard Classification numbers are shown against the electrodes for welding mild steel and the medium- and high-tensile steels, according to B.S.1719: 1951.

ERRATA

WE regret that an incorrect inscription was used for one of the illustrations on page 542 of the December 1954 issue of this journal. A double entrance/exit bus for Port of Spain, Trinidad was described as being on a Thornycroft chassis, whereas in point of fact the chassis for this bus is a Dennis "Lancet III."

On page 548 of the same issue, reference is made to a Key-Leather KL 10,000 heater, stating that the unit is capable of producing 10,000 B.Th.U/hr. Actually it produces 10,000 kilogram-calories, that is 40,000 B.Th.U/hr.

ALL-SEASON HIGH PERFORMANCE OIL

Successful Developments at the Sunbury Research Station

J. C. Cree and J. G. Withers

IN considering how to produce a "perfect" lubricating oil for automotive engines, both the functions which the oil has to perform in the engine and the users' requirements, must be taken into account. In the engine the oil must provide efficient lubrication of all sliding surfaces, prevent the formation of carbon, lacquer and sludge deposits, remain stable under extreme conditions of high and low temperature, and prevent wear. The user thereby obtains long engine life with maximum mileage between top overhauls. In addition he requires the minimum consumption of fuel and lubricating oil, and ease of starting—in fact the maximum efficiency from his vehicle with the minimum cost and effort. In the past it has not been possible wholly to satisfy all of the above demands, and compromises have had to be made, the most notable being the recommendation to use the lower viscosity oils during the winter season and of various quality levels of lubricating oils for particular types of duty.

The new all-season high performance motor oil, the development of which is now to be described, eliminates the necessity for seasonal changes of oil, and has been designed to give the highest performance under all types of service conditions while fulfilling all the demands made by the user. The production of this new motor oil is the culmination of many years of research and development both in the testing laboratory and in the field; and the purpose of this article is to discuss the unique features of this latest achievement in lubrication and to indicate the very large variety of both field and laboratory tests which have been made to substantiate its value in service beyond any doubt.

Viscosity

The internal friction of an engine represents work done by the fuel for which the operator obtains no return. When it is realized that the greater part of the internal friction in an engine is attributable to the viscosity of the lubricating oil it will be appreciated that the lower the viscosity the greater will be the miles per gallon of fuel. Over the past several years there has been a trend to recommend lower viscosity motor oils and much publicity has been given to the reduction in fuel consumption resulting from the use of such oils. At present-day prices caused by high taxation, this saving is most acceptable to both the private car owner and fleet operator alike.

However, the viscosity cannot be reduced below a certain limit, since unfortunately, the satisfactory lubrication of the working parts entirely depends upon this property and the lower the viscosity, the thinner becomes the oil film separating the parts. As the viscosity of all lubricating oils rapidly becomes less with increasing temperature, the risk of inadequate lubrication does not become serious until the engine reaches its working temperature; and the critical viscosity, so far as concerns adequate engine lubrication, is the viscosity at fully warmed-up conditions. The ideal lubricating oil should therefore have a sufficiently high viscosity at the running temperature to provide adequate lubrication and as low as possible a viscosity at starting and during warming-up.

Recommending lower viscosity oils for winter use is permissible because the fully warmed-up temperature of automotive engines is lower during this season; but in the past it has not been possible to reap the benefits of the lowest possible viscosity oil during the summer months because the fully warmed-up temperature of engines would be above the safe limit for such an oil. Again, in unpredictable weather an engine which has been changed to a low viscosity oil for the winter season may be required to do a long-distance high-speed run on a comparatively warm winter day. In these circumstances it is problematical whether, say, an S.A.E. 10W grade would be adequate. Because of this most recommendations specify S.A.E. 20W grade for winter use although often an S.A.E. 10W grade could be used with absolute safety. The modern all-season motor oil completely eliminates this difficulty and allows the benefits of a low viscosity oil to be obtained all the year round.

From Fig. 1 it will be seen that at 0 deg.F. the viscosity of the new all-season oil is the same as that of an S.A.E. 10W grade, while at 210 deg.F., owing to the much flatter temperature viscosity curve, it is equal to that of a conventional S.A.E. 30 grade; at 300 deg.F. the viscosity of the new oil is equal to that of an S.A.E. 40 grade. The new oil, therefore, while having the

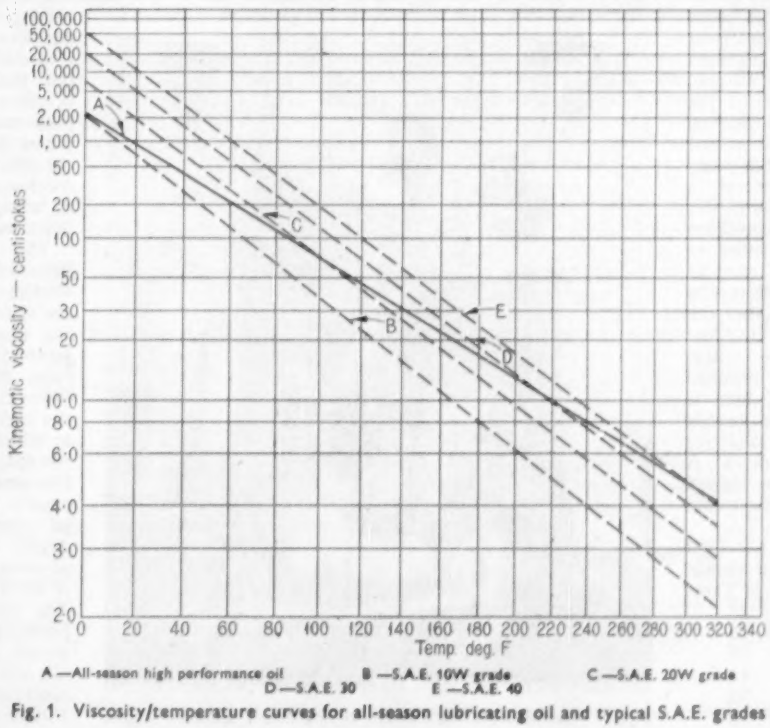


Fig. 1. Viscosity/temperature curves for all-season lubricating oil and typical S.A.E. grades

low viscosity characteristics of winter oil at low temperature, also permits safe operation at high oil temperatures brought about by increases in ambient temperature, hard driving conditions or by combinations of both factors.

TABLE I. Comparison of fuel and lubricating oil economy

Type of test	Percentage saving in fuel. All-Season Oil compared with S.A.E.30 grade during summer season			Percentage saving in lubricating oil. All-Season Oil compared with S.A.E.30 grade during summer season		
	Min.	Max.	Av.	Min.	Max.	Av.
Controlled short duration test runs	4	12	7	NIL	NIL	NIL
Uncontrolled fleet tests, involving all types of operation in various parts of U.K.	NIL	15	5	NIL	50	15
Controlled high speed tests, made on German autobahn (2,000 mile tests at average speed of 55 m.p.h.)	0·5	11	4	NIL	50	30

Effect on fuel consumption

Obviously the saving in fuel which can be obtained by the use of the all-season oil will vary with the type of duty upon which the vehicle is engaged; the largest fuel saving will be obtained with vehicles engaged upon intermittent runs of short duration where the crankcase temperature never reaches warmed-up conditions, and the least saving on fast long distance runs. The importance of the warm-up period in determining overall fuel consumption can be understood from the fact that at least one hour's driving is necessary before oil temperatures reach their maximum values. However, even under warmed-up conditions the advantage is still in favour of the all-season oil.

Comparative data obtained from extensive fleet tests made in Southern England, the Midlands, Scotland and Wales, controlled fleet tests conducted from the Research Laboratory, and high-speed fleet tests made on the German autobahns are given in Table 1. All types of vehicle were engaged on these tests from the smallest British passenger car to large American models, together with some of the more popular Continental vehicles. The ages of the vehicles used for the work were representative of a cross-section of those in this country, the engine condition varying from 500 miles to 40,000 miles since new or major overhaul. The results show, as expected, that the greatest advantage in fuel saving occurs on short journeys; but it is believed that this type of duty is representative of the manner in which the large majority of vehicles are operated. A survey made in the United States[1] has produced the following data:—

Analysis of Passenger Car Trips

Length of journey, miles	Percentage of Trips
0-2	28
2-4	20
4-6	15
6-10	12
10-16	10
Over 16	15

It is considered that if a similar analysis were made in this country, it would not differ appreciably from the above.

Effect on lubricating oil consumption

Apart from leakage, lubricating oil consumption can be attributed to three causes: volatilization of the oil film which is left on the cylinder walls during the combustion stroke; pumping action of the piston rings; and seepage down the valve guides. The first of these causes can be discounted since oil consumption due to evaporation is only significant with the lightest grades in the S.A.E. 5W viscosity range.

The quantity of oil consumed due to the other two causes is directly related to the wear that has occurred. This is why the oil consumption of any engine gradually increases during its life. However, when an engine has reached the stage where oil consumption is high the viscosity of the oil at the working temperature still plays an important part in the control of the consumption. A lighter grade lubricating oil will more easily be pumped into the combustion space by the piston rings and also larger quantities will seep past the valve stems to be burnt on the undersides of the valve heads. This is borne out by experience in service when using ordinary winter grade oils in worn engines.

The temperature in the piston ring belt of the average engine is in the region of 300 deg.F.; Fig. 1 shows that at this temperature the special oil has a viscosity equivalent to that of an S.A.E. 40 grade. Similarly, owing to the elevated temperature of the valve stems and guides, the viscosity of the oil in contact with these parts is at least equivalent to that of an S.A.E. 30 grade. Thus, as far as oil consumption is concerned the new oil should behave like the more viscous conventional oils; and it will be seen from the data on oil consumption presented in Table 1 that the experience gained from the various service tests on the new lubricating oil bears out this view.

Effect on starting

A third advantage which is to be gained from the viscosity characteristics of the new oil is ease of starting throughout the year. A consideration of this aspect of engine performance has been published previously[2] in which the effect on starting of both mechanical factors as well as lubricating oil characteristics were discussed.

The properties of the lubricating oil which affect starting are the viscosity at the starting temperature and the proximity of the pour point to the starting temperature. It is obvious that the lower the viscosity of the oil the higher will be the speed at which the engine can be rotated, due to the decreased frictional losses; and reference to Fig. 1 shows that for all temperatures below 100 deg.F. the viscosity of the all-season oil is below that of an S.A.E. 20W grade oil. The estimated lowest temperatures at which conventional S.A.E. 30 and 20W oils will permit starting from dead cold are 25 deg.F. and 15 deg.F. respectively, com-

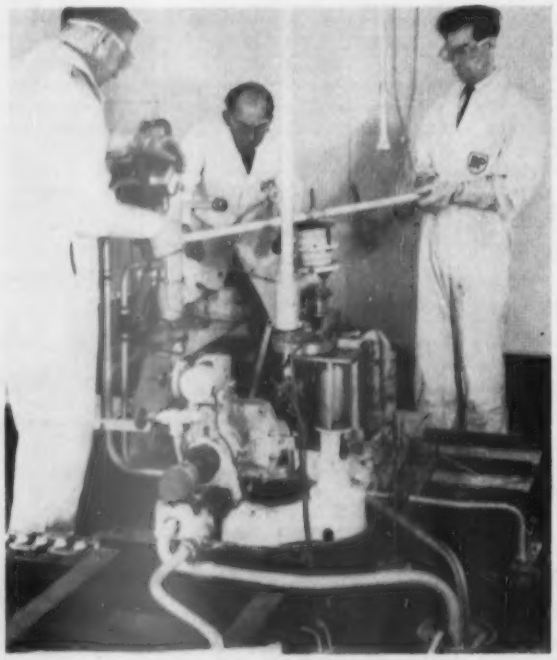


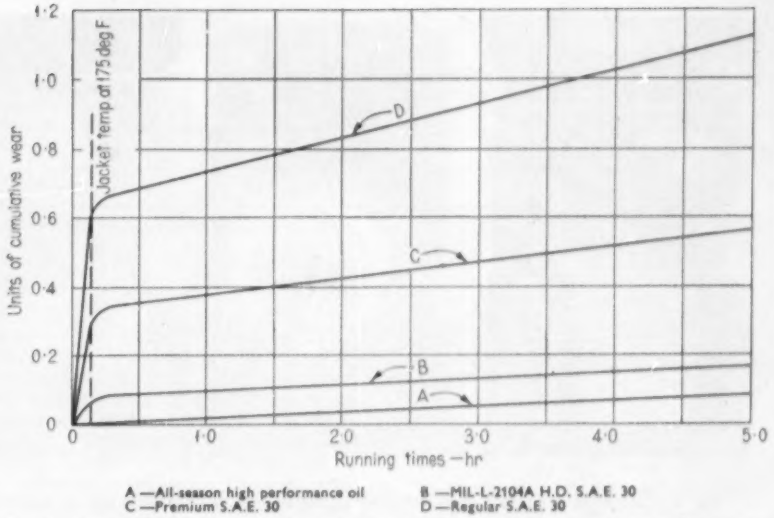
Fig. 2. Assembling a radio-active engine into a Sunbury Engine

pared with 0 deg.F. for the new all-season oil. However, in temperate climates, starting at 0 deg.F. is not required, and the important factor is the increase in cranking speed resulting from lower viscosity at temperatures in the region of 20 deg.F. which is an extreme condition for the U.K. Under these conditions the initial torque required to turn the engine with the all-season oil is under half that of a conventional S.A.E. 20W oil and the final cranking speed will be about 50 per cent higher. Increases in cranking speed will also be experienced at higher starting temperatures. Reduced wear and tear of the battery results from the reduction in power required to bring the engine to its starting speed, and a further improvement in battery life results from the fact that the battery can drop more in capacity before it fails to start the engine. In addition, because of lower frictional losses, once the engine has started it is less likely to stall on release of the choke; this means that the choke can be released earlier, which is an additional contribution to the fuel saving experienced with the new oil.

As previously stated[2] the effects of low viscosity oils on ease of starting can only be fully realized if the pour point of the lubricant is not approached too closely. However, with the new lubricating oil, the pour point is in the region of −40 deg.F. Therefore, adverse effects from this source can be discounted even under the most severe winter conditions which occur on the Continent.

Anti-wear properties

One of the most important features of the performance of a lubricating oil is its ability to reduce wear. The life of an engine, or at least the operating time between major overhauls which involve the expense of a rebore, is wholly governed by wear of the cylinder bores and piston rings. Wear in an engine can result from any or all of the following causes:—



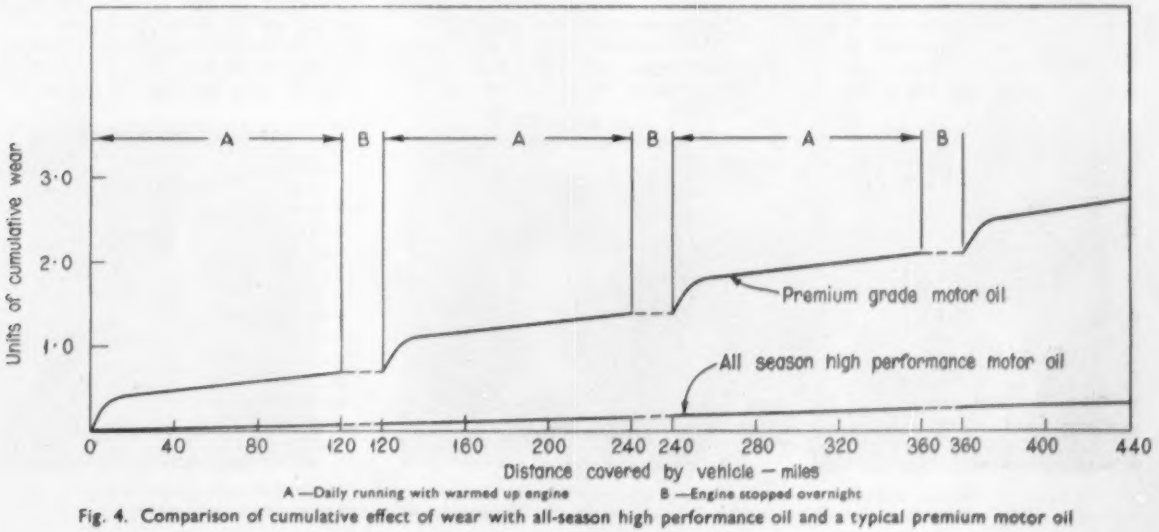
A —All-season high performance oil B —MIL-L-2104A H.D. S.A.E. 30
C —Premium S.A.E. 30 D —Regular S.A.E. 30

Fig. 3. Comparison of wear during warm-up period and steady running conditions at 175 deg.F. jacket temperature. Data obtained by using a radio-active piston ring

1. Corrosion from acids in the products of combustion.
2. Abrasion from foreign matter reaching the engine through the air intake, crankcase breather or with the lubricating oil.
3. Indirect effects resulting from the presence of deposits.
4. Oil starvation at start up.
5. Rupture of the oil film at high temperatures with low viscosity oil.

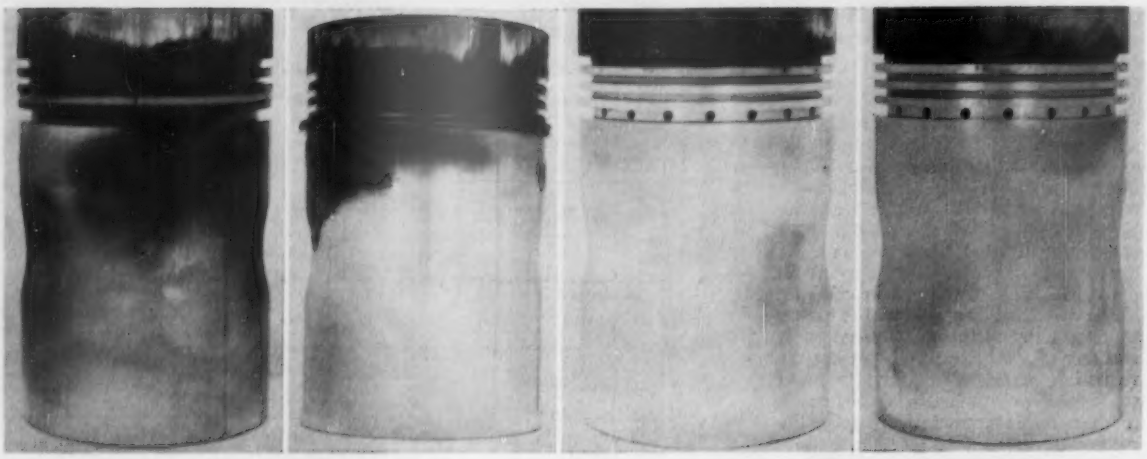
The problem of preventing the entry of abrasive material into the engine is mainly one of design and the use of efficient filters; nevertheless the increased film strength of additive motor oils can help to offset abrasive wear by reducing the tendency of small particles to rupture the oil film. Wear effect due to the build-up of deposits is almost entirely eliminated by the use of detergent additives, the importance of which will be amplified later. Oil starvation at start-up and rupture of the oil film are overcome by the viscosity characteristics and film strength properties of the all-season motor oil. It has already been pointed out how the low viscosity of this oil at low temperatures ensures an adequate oil supply at start-up, while at the high temperatures its viscosity is equal to that of an S.A.E. 40 grade.

Experience gained over many years has shown that the greatest wear in engines occurs when they are engaged upon short stop-start duties as in doctors' cars, delivery rounds and taxi services. From a previous consideration, it appears that this type of duty is also representative of that of a large proportion of passenger cars. Although the type of duty which causes wear is well known it was not until comparatively recently that is was possible to investigate thoroughly the fundamental mechanics. Prior to the advent of radio-active isotopes on a commercial scale the only method available for investigating the effect of lubricating oils on wear was to run the engine until



A —Daily running with warmed up engine B —Engine stopped overnight

Fig. 4. Comparison of cumulative effect of wear with all-season high performance oil and a typical premium motor oil



(a) (b) (c) (d)

Fig. 5. Caterpillar L.1 pistons lubricated by (a) regular oil, (b) premium oil, (c) heavy duty oil, (d) all-season high performance oil

sufficient metal has been worn off the piston rings or cylinder bores to enable measurements to be made on a comparative basis, by weighing the piston rings, and measuring the cylinder bores by micrometer or other sensitive measuring techniques. Wear rates over very short periods of time could not be obtained; and, because the engine had to be dismantled between each set of measurements, the arrangement of the piston rings was disturbed, which often led to inaccurate comparisons.

The modern technique for investigating wear makes use of the fact that cast iron subjected to irradiation in an atomic pile becomes radio-active. A standard piston ring for a particular engine is subjected to irradiation for a period of four weeks in the neutron pile at the Atomic Energy Research Establishment at Harwell. After irradiation it is allowed to stand for a week outside the pile so that the short-lived radiations from the impurities in the metal decay, and then it is transported to the engine test laboratory and fitted to the piston. Special long handled tools are necessary for this operation, together with other precautions, to avoid the personnel approaching too near to the irradiated piston ring. An illustration of an engine being assembled, with the radio-active ring in position, is shown in Fig. 2.

The principle underlying the radio-active tracer technique for the measurement of engine wear is that metal removed from the piston ring in the form of corrosive products or rubbed off due to abrasion is carried back to the sump by the lubricating oil. Consequently, the rate at which the radio-activity of the sump oil increases is directly proportional to the rate of engine wear which is taking place; due allowance however must be made for the natural decay in activity of the piston ring.

At the Research Station with which the authors are associated the practice which has been adopted is to circulate the sump oil continuously through a counting arrangement while the engine is running. The oil is pumped from the crankcase through an enclosed container surrounded by six Geiger-Müller tubes connected in series to a Scaler unit. After passing through the assaying vessel the oil flows back to the sump. The circulation rate of oil through this system is maintained at 30 gallons per hour, which is equivalent to passing the whole of the oil in circulation through the counting arrangement once every minute.

This method provides an accurate means with which to measure the radio-activity of the sump oil over periods as short as five minutes and allows continuous records of wear to be obtained. The other major advantage of the radio-active tracer technique is that when changing from one oil to another the engine is not dismantled in any way, but merely drained and flushed with the oil to be tested. However, when investigations are made on lubricating oils containing additives which display anti-wear properties it has been found necessary to run the engine for several hours, and to repeat the flushing procedure before continuing with the next oil, as traces of these additives are sufficient to have a significant effect on results. During the work which led to the formulation of the new motor oil the maximum use was made of the radio-active tracer technique. The Sunbury Engine[3] was chosen for this investigation as it was designed for research work, and was easily adaptable for running under practically any operating conditions.

In the preliminary work it was found that the total wear incurred during the first 10 minutes after starting from cold, using a regular grade motor oil, was equivalent to that which took place during six to eight hours running at fully warmed-up conditions, or that the average rate of wear during the first ten minutes after starting the engine was

(a) (b) (c)

Fig. 6. Sunbury engine pistons lubricated by (a) regular oil, (b) premium oil, (c) all-season high performance oil

between 30 and 40 times as great as during warmed-up running. Although a substantial increase in the wear rate obtained, between 8 and 10 times, when the jacket temperature was maintained at the low temperature of 75 deg.F., it was demonstrated that the high rate of wear during the first several minutes after start-up was not merely due to running with a low jacket temperature. Subsequent work led to the conclusion that the wear observed at start-up is, in fact, largely a result of corrosion which occurs while the engine is shut down overnight. After shut down condensation of the acidic gases left in the cylinder occurs and the acidic condensate attacks the cylinder walls and piston rings. During the short period following start-up both the metal contained in the products of corrosion, and the particles of metal removed by abrasion due to these products of corrosion, are carried down to the sump and give the indication of a very high rate of wear. After the nature of the wear which occurs in vehicles engaged in stop-start duties had been determined, steps were taken to incorporate additives into the lubricating oil which would prevent this wear, or at least reduce it to a minimum.

For the final testing the radio-active tracer technique was used in conjunction with operating conditions which simulated those likely to be encountered in practice. The engine was started up from cold and run up to steady operating conditions of 2,500 r.p.m. at a b.m.e.p. of 60 lb/in^2. The thermostatic temperature controller in the water jacket was set to bring the water jacket temperature up to 175 deg.F. in the first 10 minutes after starting the engine, which is the approximate time taken for a modern vehicle fitted with a thermostat to attain warmed-up conditions in the cooling water system.

Comparative results obtained from a Regular S.A.E. 30 grade, an oil representative of currently additive-type Premium S.A.E. 30 grade oils, the All-Season High Performance Motor Oil, and an H.D. S.A.E. 30 oil which had received MIL-L-2104A approval, are shown in Fig. 3. Although the curves show only one period of operation, the engine had been run for at least one preceding period on the same oil.

Apart from the almost negligible wear rates of both the H.D. and the all-season motor oil at steady operating conditions, indicated by the slopes of the curves, it will be noted that no increase in wear rate, over and above the very low wear at steady running conditions, was recorded with the all-season motor oil. It is considered that the reduction in this respect compared with the Heavy-Duty oil is a function of the surface-protecting properties and the viscosity characteristics of the new motor oil, which ensure that corrosion during shut down does not take place and that adequate quantities of oil are immediately available on start-up.

Fig. 4 demonstrates the cumulative effect of eliminating start-up wear and reducing the wear at steady running conditions to a very low level. The assumptions made in this comparison are that the engine is started only once during the day and that it runs continuously for four hours at 30 m.p.h. It will be appreciated of course that if, as is more usual, more frequent cold starts are made the divergency of the two curves will be correspondingly greater.

TABLE II. Results of sludging tests in 2·2 litre automotive engine

Test oil	*Total merit rating for condition of engine Parts	Weight of sludge settled in sump lb.
Regular oil	74	2·0
Premium oil	84	1·3
All-season high performance oil	91	0·3

*100 *merit rating is given to a perfectly clean engine.*

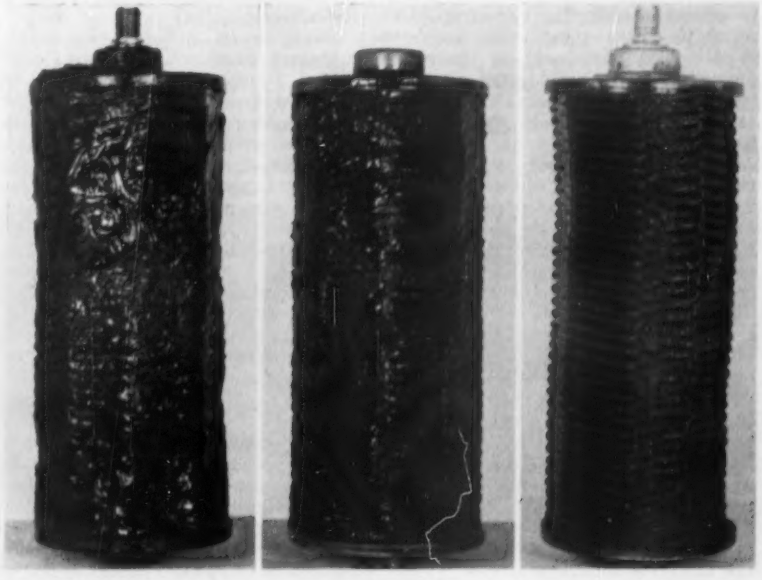
Engine cleanliness

The ability of a lubricating oil to maintain an engine in a clean condition is of prime importance. If an engine is kept free from deposits there is a further reduction in maintenance costs over and above that resulting from reduced wear, because of less frequent overhauls. The factors that have to be taken into account when designing a lubricating oil to give maximum performance with respect to engine cleanliness are:—

1. The stability of the oil itself; under the high temperature conditions which the lubricating oil encounters on the cylinder walls and in the piston ring belt, unstable oils form insoluble resins which give rise to lacquer and carbon deposits. These deposits are due to the direct oxidation of the oil and to reactions which occur between the oil and hot combustion gases.
2. The ability of the oil to prevent the formation of combustion chamber deposits which, if allowed to build up, will cause pinking and increase the octane number requirement of the vehicle.
3. The ability of the lubricating oil to keep in suspension in a very finely divided state, carbonaceous material, lead compounds, and other solid or easily oxidisable fluid contaminants which originate from the combustion chambers. These materials can cause piston ring sticking and other troubles.
4. The ability of the oil to prevent the formation of sludge deposits such as occur under low temperature stop-start conditions.

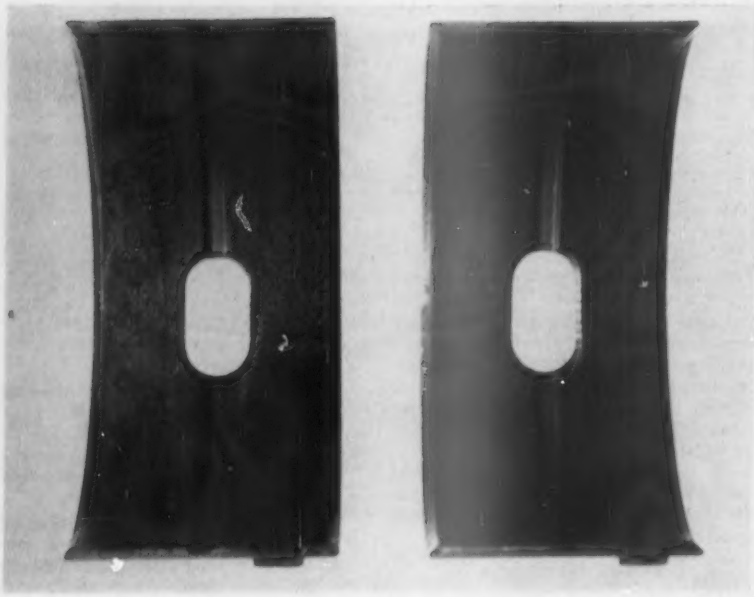
Oil stability

Stability of a lubricating oil is connected with the selection of the most suitable crude stocks and with the type and degree of the refining treatments. While the use of additives in poor quality basic oils will improve their performance, it is only possible to attain the really high performance



(a) (b) (c)

Fig. 7. Lubricating oil filters after 6,000 miles service tests in a commercial spark-ignition engine, lubricated by (a) regular oil, (b) premium oil, (c) all-season high performance oil



(a) (b)

Fig. 8. Results of Chevrolet L.4 high temperature bearing test, showing (a) a corroded bearing after tests on regular oil and (b) a non-corroded bearing after tests on all-season high performance oil

standards by using properly refined basic components.

Combustion chamber deposits

The build-up of combustion chamber deposits raises the octane requirement of the engine and even causes pre-ignition; this results in a higher proportion of running in lower gears to avoid pinking with consequential increases in fuel consumption, or to the extra expense of frequent top overhauls. Experience has shown that careful selection of a basic distillate oil of narrow boiling range, rather than blending light and heavy components to obtain a particular viscosity, does much to reduce combustion chamber deposits. Oils prepared in this way give much longer running times during which the octane requirements of the engine are fully satisfied by available fuels.

Combustion chamber deposits are also influenced by the additives used in detergent oils and care must be taken to ensure that these do not have an adverse effect. However, certain types of additives play a significant part in reducing combustion chamber deposits. The small amount of ash which results from normal oil consumption has the property of rendering combustion chamber deposits friable when a suitable type of additive is used, and both the additive ash and carbon deposits are then continuously purged from the combustion space and exhaust valves in the form of a fine powder.

Piston deposits

Their importance may be seen from the following considerations:—

1. The formation of lacquer and carbon in the ring belt zone restricts the operation of the piston rings; this leads to increased blow-by and, in turn, to charring of the oil film and high rates of wear.
2. Carbon deposits may also flake off when they reach a certain thickness, and abrasive wear ensues due to the grinding of these carbon chips by the operation of the piston in the cylinder.
3. Lacquer deposits on the piston skirt prevent the heat flow from the piston through the cylinder to the water jacket. This causes the piston temperature to increase and accelerates the processes of 1 and 2 above.

Owing to its inclusion in widely publicised specifications[5–6–7] the Caterpillar L.1 test procedure[8] has come to be regarded as the criterion for high-performance lubricating oils with respect to detergency under endurance conditions of operation. To meet the generally accepted standards for a high-performance detergent oil a virtually clean piston must be obtained when the oil is tested by this procedure. The relative Caterpillar L.1 performance of the new motor oil is demonstrated in Fig. 5.

The Caterpillar L.1 procedure proves the performance of detergent oils for the type of duty which it simulates, and gives a good first indication of the detergency of an all-purpose lubricating oil. However, it is also necessary to ensure that an oil displays the same characteristics when subjected to conditions pertaining to a gasoline engine. To cover this aspect tests have been carried out simulating hard-driving conditions, using the Sunbury engine[3–4] which is a spark ignition engine of 2½ in bore and 3¼ in stroke. For this test the engine was operated at a speed of 2,500 r.p.m., a b.m.e.p. of 80 lb/in², an oil temperature of 170 deg.F. and convection cooling only of the cylinder liner; the duration of the test was 150 hours. The engine was run with an abnormally high cylinder temperature which accelerates the breakdown of oils prone to this trouble. Fig. 6 compares the performance under these test conditions of the new oil, a regular grade and a currently marketed additive-type Premium Motor Oil. The high level of detergency of the new oil is shown by reference to Fig. 6.

Cold sludging

The remaining engine cleanliness factor which has to be considered in formulating the ideal oil is the ability to prevent the formation of sludge in engines run with low sump temperatures, or under city driving stop-start conditions, which entails a high proportion of idling. Sludge in an engine results from solid products of combustion, partially burnt fuel, and water carried down to the sump with the blow-by past the pistons, together with break-down products from the oil. From the nature of the resulting deposits it is evident that the water from the combustion emulsifies with the break-down products of the oil and partially burnt fuel and in so doing coagulates the solid contaminants to form a pasty material with the consistency of mayonnaise.

Sludge formation results in early choking of scraper ring grooves and oil filters. Choking of scraper rings cannot be tolerated because it causes high oil consumption. Filters choke because the coagulates will not pass through the fine pores; hence, either frequent servicing is necessary or the filter is by-passed and the harmful solid materials are allowed to circulate through the oil system.

Fatigue and resultant early failure of white metal alloy bearings are also associated with sludge formation. The coagulates of sludge enter the bearing, and, as they come under load, displace the soft bearing metal to form a crater. After causing the damage the solid particles are then flushed from the bearing by the oil stream; but the rim of the crater forms a raised area where load concentrations cause partial interruption of the oil film, leading to excessive heat and accompanying fatigue. It has been stated[9] that temperature rise in bearings is one of the most frequent causes of fatigue failure and that the life of a tinbase babbit bearing is approximately doubled by reducing the bearing back temperature from 280 deg.F. to 250 deg.F.

Corrosion of metal parts and valve spring failures are associated with sludge deposition. The consistency of the sludge is such that it adheres to any surface which is not being continually wiped by a mating component; the water in the sludge is in direct contact with the metal and corrosion ensues. With valve springs this corrosion takes the form of small pits on the highly

stressed surface which lead to stress concentrations and failure through fatigue.

To overcome the problem of sludge formation a lubricating oil must have adequate dispersant properties, and inherent stability to prevent the formation of oil break-down products which act as the emulsifying agent. In the modern high performance lubricating oil both of the necessary qualities are obtained by using selected basic lubricating oils, and detergent and anti-oxidant additives.

A laboratory engine test has been devised at the Sunbury Research Laboratory to investigate sludge forming tendencies. This involves running a four cylinder 2·2 litre automotive spark ignition engine through a fixed cycle of conditions. Each cycle consists of an idling period of three minutes duration followed by ten minutes at warmed-up conditions, and finally, a further period of two minutes at idling conditions. The engine is then shut down for 15 minutes during which time cold water is circulated through the jacket and sprayed on to the outside of the sump. This reduces the temperatures within the engine to those encountered at starting from cold before the operating cycle is repeated. To simulate the increased blow-by in a worn engine in a manner which enables a close control of operating conditions to be maintained, the piston rings are assembled with gaps of 0·075 in instead of the standard 0·012 in.

It has been found that a test duration of 500 cycles enables accurate assessments to be made of the ability of a lubricating oil to prevent sludge. The sludge is assessed by a merit rating based on the thickness and extent of the deposits on individual engine components, and by the weight of sludge which separates in the sump after allowing the sump oil to stand for two hours. Comparative data obtained using the above test procedure are given in Table II and the relationship of these data to service performance is indicated by Fig. 7 which compares the condition of oil filters taken from three cars which had each completed 6,000 miles on the road.

Corrosion of copper-lead bearings

Bearings of this type have a higher load carrying capacity than that exhibited by white-metal alloys, and their use is becoming more widespread as power/weight ratios of engines are increased. However, they are not entirely free from possible trouble as they are susceptible to corrosion from oil break-down products both at very high and at very low temperature operating conditions.

High temperature corrosion

The chevrolet L.4 test[8] has been used for many years to ensure that high temperature corrosion troubles will not be encountered in service. This test procedure is included in specifications for heavy-duty oils, and it has been stated by authoritative bodies that since its adoption no high temperature corrosion troubles have been encountered in service. The only objection that has been made to the procedure is that its severity is far above that of any service conditions, and the degree of safety given by oils which pass the test is considerably greater than is really necessary.

Fig. 8 illustrates the difference in appearance of a Chevrolet L.4 bearing after a test on the new all-season high performance motor oil, which gave complete freedom from hot corrosion of copper-lead bearings, and a test on a typical Regular grade oil, which gave heavy corrosion.

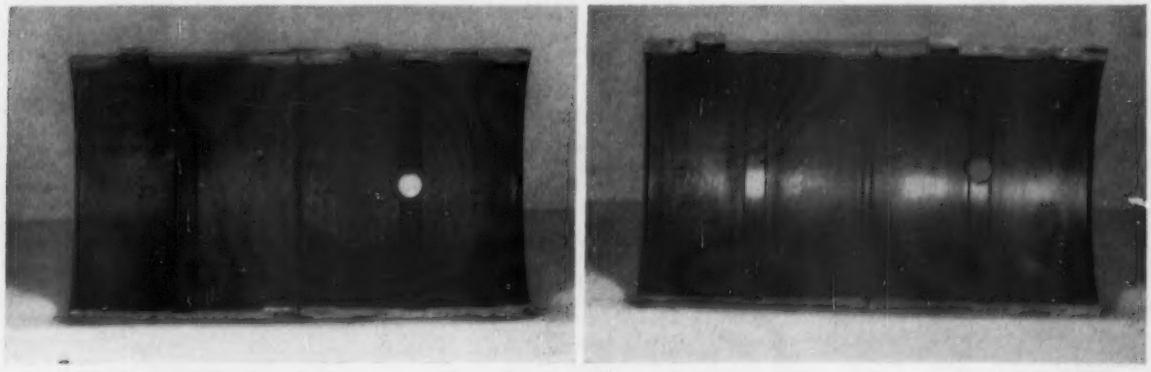
Low temperature corrosion

The cold corrosion which may be encountered with copper-lead bearings results from the break-down of certain additives in the presence of acidulated water originating from the condensation of blow-by gases when engines are run at low temperature in cold climatic conditions. The trouble is really one which can, to a large extent, be overcome by taking the necessary steps to ensure that engine temperatures are kept as high as possible, such as by using radiator muffs and blanking off sections of the radiator under severely cold conditions. Other factors which can contribute to this type of corrosion are poor design of the oil sump and inadequate allowance for crankcase ventilation. If the area of the sump exposed to the air stream under a vehicle is unnecessarily large considerable condensation will take place on the walls of the sump and in the breather pipe in cold conditions; good crankcase ventilation is very effective in reducing condensation.

The structure of the copper-lead bearing itself also has an influence on the severity of the cold corrosion as fine grained copper-lead bearings are less prone to the trouble than are coarse grained bearings[10]. Even so, occasional cases of severe cold corrosion of copper-lead bearings do occur in service. On the basis that the ideal oil must perform satisfactorily under any conditions, the necessary steps have been taken with the all-season oil to cover this contingency.

The laboratory engine test which has been devised to ensure freedom from cold corrosion again makes use of the Sunbury engine. For this test it is operated at a speed of 2,000 r.p.m. and a b.m.e.p. of 80 lb/in². The jacket and sump temperatures are maintained at 104 deg.F., and the blow-by gases leaving the crankcase are cooled to 80 deg.F. which is a few degrees below their dewpoint; in addition, the humidity of the intake air is controlled by means of an ice tower. These measures effectively control the amount of condensation in the crankcase from the blow-by gases and ensure good repeatability. As the rate of break-down of the additive to give this type of corrosion is governed by the amount of blow-by encountered, ring gaps are increased to give a constant blow-by rate of four times that which would be obtained with a new engine which had completed its break-in run.

The duration of the test is 50 hours, and, as in the high temperature Chevrolet L.4 test, the assessment is based upon both the weight loss and appearance of the bearings. Fig. 9 shows a bearing after a test on the all-season high performance oil compared with that after a test on a heavy-duty oil which met the requirements of MIL-L-2104A and DEF/2101A specifications, but was nevertheless shown



(a) (b)

Fig. 9. Results of low temperature bearing corrosion test in Sunbury engine, showing (a) corroded bearing after test on MIL-L-2104A oil containing unstable additive, and (b) non-corroded bearing after test on all-season high performance oil

by this test to contain an additive which was unstable in the presence of acidic condensate from blow-by gases. Service tests made on the Continent in Alpine country under winter conditions have been used to establish the practical value of this cold corrosion test.

General conclusions

The unique viscosity characteristics of the new high performance oil make for economy in fuel and lubricating oil consumption, easy starting, and prolonged battery life. A very major reduction in engine wear is achieved, brought about largely by the anti-wear, detergent, and anti-oxidant additives incorporated in the formulation. These result in considerable overall economy in operational costs. The detergency characteristics of the new oil are those of a high quality heavy-duty oil, ensuring a considerable extension of the time before decarbonization becomes necessary.

It will be seen from the considerations cited in this article that in every aspect of engine lubrication, throughout the wide variety of operating conditions encountered in service, an oil prepared from selected base materials and containing well balanced proportions of suitable additives shows very marked advantages over previously marketed oils. The distance that can be covered between oil changes will depend upon factors such as the amount of dust in the atmosphere and the degree of filtration of the air-intake and crankcase breather which affects the amount of dirt entering the engine. The quality level of the new oil ensures that it will remain effective for relatively long periods; but it is not recommended that oil change periods should be extended beyond those recommended by the manufacturer if the full benefits are to be obtained.

In conclusion, the authors wish to thank the Chairman of The British Petroleum Company Limited for permission to publish this article which covers work carried out on the performance of motor lubricating oils at the Sunbury Research Station, and their co-workers who have been engaged upon the development of the all-season high performance motor oil.

References

1. W. OWEN; "Automotive Transportation in Defence of War", Alfred Politz Research, Inc., October 1951.
2. J. G. WITHERS; "Engine Lubricating Oils", Automobile Engineer, Vol. 42, Oct. 1952, 387-393.
3. J. R. CROWTHER, T. E. Pitkethly and R. Stansfield; "The Sunbury Lubricating Oil Test Engine", J. Inst. Pet., 1949, Vol. 35, 246-258.
4. R. STANSFIELD; "The Sunbury Test Engine", Schweitzer Archiv, Vol. 18, Feb. 1952, 46-62.
5. "Lubricating Oil, Internal Combustion Engine, Heavy Duty", U.S. Military Specification MIL-L-2104A, Feb. 1954.
6. Ministry of Defence Specification DEF/2101A, July 1954.
7. Engine Lubricating Oils (H.D. Type), British Standards Specification 1905: 1952.
8. C.R.C. Handbook 1946, Co-ordinating Research Council Inc.
9. E. CRANKSHAW and W. WEINKAMER; "Visually Analyzing Bearing Troubles", Diesel Power and Diesel Transportation, Vol. 31m October 1953, 59.
10. H. H. ZUIDEMA; "Performance of Lubricating Oils", Reinhold Publishing Company. Chapter 4.

RECENT PUBLICATIONS

Brief Reviews of Current Technical Books

Engineering Dynamics, Vol. IV: Internal Combustion Engines

By C. B. Biezeno and R. Grammel.

Glasgow: BLACKIE AND SON, LTD., 17, Stanhope Street, C.4. 1954. 7 × 10. 282 pp. Price 50s.

Text books and elementary lecture courses covering the syllabus of engineering mechanics have to deal mainly with simplified academic problems. For want of space and time, the more complex practical problems met with by designers cannot be treated adequately in these works. Moreover, they cover such a wide range of applications that they are, in many cases, of limited value for reference purposes or for use in specialized branches of engineering. However, this book is different in that it covers a specialized field of engineering and the authors have set out to make it in effect a continuation of the usual text book. In fact, it virtually represents a post graduate course. Throughout the book, the assumption is therefore made that the reader is well versed in elementary mechanics and mathematics.

The authors have kept in mind the facts that technical problems are generally worth solving only if they can be applied in practice, and also a solution is complete only when all the details of the problem can be numerically enumerated with a tolerable amount of arithmetical work. A whole chapter of the book has been devoted entirely to methods of solution of problems. Solutions are not given merely in outline, but every detail has been developed in the way in which a designer has to do the work.

Since the solutions are given in great detail, it has been possible to include only a limited number of the more important technical problems. Treatments of special subjects that have been extensively covered in other publications have been shortened and in some cases omitted. The authors have aimed at dealing mainly with those problems to which they could contribute something of their own. This is a sound principle, since those who have worked on and contributed to a solution of a problem are generally best qualified to explain it to others.

Part I of the work deals with inertia forces. It is divided into the following sections: the one-cylinder engine; the in-line engine; engines with special features; V-, multi-row and radial engines with articulated connecting rods; V-, fan-like in banks and radial engines, rotary and counter-rotating engines. Part II is headed "Power smoothing" and it comprises two sections: one is the one-cylinder engine and the other the multi-cylinder engine. Part III deals with torsional vibrations.

The Grand Prix Car, Vol. 1

By Laurence Pomeroy, F.R.S.A., M.S.A.E.

London: MOTOR RACING PUBLICATIONS LTD., 81a, Grays Inn Road, W.C.1. 8½ × 11. 268 pp. Price 63s.

This, the second edition of "The Grand Prix Car," is being sold exclusively through Temple Press Ltd. Whereas the first edition was in one volume entitled "The Grand Prix Car 1906-1939," the new one is in two, Volume I dealing with the same period as the whole of the first edition. The text in the second edition has been revised and extended. It is illustrated by 87 line drawings, 13 two-page pull-out drawings and 32 pages of plates, as well as 14 pages of L. C. Cresswell's pencil sketches reproduced by photo-litho. An appendix gives details of both the results and fastest laps in the 200 most important races up to the outbreak of World War II.

Of the Grand Prix cars for which detail descriptions and drawings are given, the earliest was built in 1908. It had an engine of 12 litres swept volume, and attained a maximum speed of 100 m.p.h. The last car described is the Mercedes Benz 1939 model, which had a swept volume of only 3 litres but a maximum speed of little under 200 m.p.h. This book should be of considerable interest both to technicians and to racing enthusiasts.

Verschleiss, Betriebszahlen und Wirtschaftlichkeit von Verbrennungskraftmaschinen (Wear, Performance and Economy of Internal Combustion Engines)

By Dr.-Ing. Carl Englisch.

Vienna: SPRINGER VERLAG, Molkerbastei, 5. 1953. 7½ × 10½. 228 pp. 393 illustrations and graphs. Price $12.70.

This work is the 14th volume of "Die Verbrennungskraftmaschine" (The Internal Combustion Engine) edited under the auspices of Prof. Dr. Hans List, Graz. In this work, the author, who is a well-known Continental authority, deals with all possible aspects of wear in piston-type internal combustion engines as used in automotive, stationary and marine applications. The references to the various types of surface finishes employed for certain components provide valuable information.

Individual chapters are devoted to cylinders, pistons, valves and bearings, with a special reference to the wear characteristics of alloy bearing materials. In the section dealing with the economic aspect of the internal combustion engine, the author in dealing with the details of fuel consumption relates those with certain features of design and presents thereby a study which throws some interesting light on details based both on pure research and operating experiences. In this section reference is also made to research work on engines equipped with exhaust-turbo compressors.

SYNTHETIC PAINT FINISHING

Perfectair Plant for the Swallow Doretti

AN interesting automobile body painting plant for the two-litre Doretti sports car was recently installed by Perfectair Ltd., 314-314A, Balham High Road, London, S.W.17, at the Walsall works of Swallow Coachbuilding Co. (1935) Ltd. Complete synthetic paint treatment is carried out. Essentially, the plant, which is arranged for batch production, comprises a dry-off oven, a spray booth with entrance and exit vestibules, a primer stoving oven, and an enamel stoving oven. Access to both stoving ovens is from the spray booth exit vestibule. To facilitate ease of treatment and spraying, the car body is mounted on a revolving spit-type truck, which is manually pushed through the sequence.

Before any painting is carried out, Deoxidine is applied to the aluminium body. This is done to produce a surface to which the paint will key. After this application, the body is given a cold and a hot water rinse, and is then pushed in to the dry-off oven where the moisture is evaporated in 15 minutes at 300 deg F. From the dry-off oven the body on its truck is pushed into the spray booth. Two coats of high lustre primer surfacer are applied wet-on-wet, and the body is then trucked into the primer oven where it is stoved for 25 minutes at 350 deg F. After this stoving, synthetic stopper is applied to the hot body prior to water-sanding. Following this, the body is again rinsed and then dried off as before in the dry-off oven.

Before any colour is applied, the body is wiped off with spirit in the open shop and then tack-ragged in the air conditioned entrance vestibule of the spray booth. One coat of sealer, followed by two coats wet-on-wet colour are then applied underneath the bonnet, round the bonnet edges to the door shuts, underneath boot-lid, around the boot-lid shuts. This paint application is stoved for 25 minutes at 315 deg F in the primer oven. On leaving the oven the body is inspected and is then dry-flatted and rubbed down with spirit. Following this the body is again pushed into the entrance vestibule of the spray booth for a further rubbing down with tack-rags. Finally, two coats of synthetic enamel are applied and the body is then stoved in the enamel oven for 45 minutes at 275 deg F.

This plant is situated in an aircraft hangar, as may be seen from Fig. 1. In this illustration, the two stoving ovens are shown in the foreground with the spray booth entrance in the centre and the dry-off oven in the background. All three ovens are of the forced-air circulated convection type. The dry-off and primer ovens have direct gas-fired furnaces, but the enamel oven is operated on an indirect gas-fired system to prevent discharge of the products of combustion into the oven. All three ovens have pneumatically operated vertical lift doors and the primer and enamel ovens also have "winching out" gear for withdrawing the stoved bodies. To ensure correct stoving times, time switches operate warning lights that indicate when the body should be withdrawn.

Fig. 2 shows the enamel oven with both doors open. The smooth steel panelled interior facilitates cleaning and thereby ensures the completely dust-free atmosphere that is essential for perfect stoving. The forced air supply or distribution duct is sunk below floor level, the air being delivered into the oven along the longitudinal centre line. The air exhaust or recirculation duct is mounted at ceiling level. Air exhaust slots are provided along the entire length of this duct.

As cleanliness is an absolute essential for all synthetic paint plant, particular attention has been given to the atmospheric conditions of the various zones in which the work is carried out. The entrance vestibule—where all tack-rag operations are carried out—, the spray booth—where all paint is applied—, and the exit vestibule—through which the wet painted body is transferred from the spray booth to either the primer or enamel oven—are all totally enclosed pressurized areas. They have sides and ceilings fabricated from completely smooth steel panels, so that there are no ledges where dust can

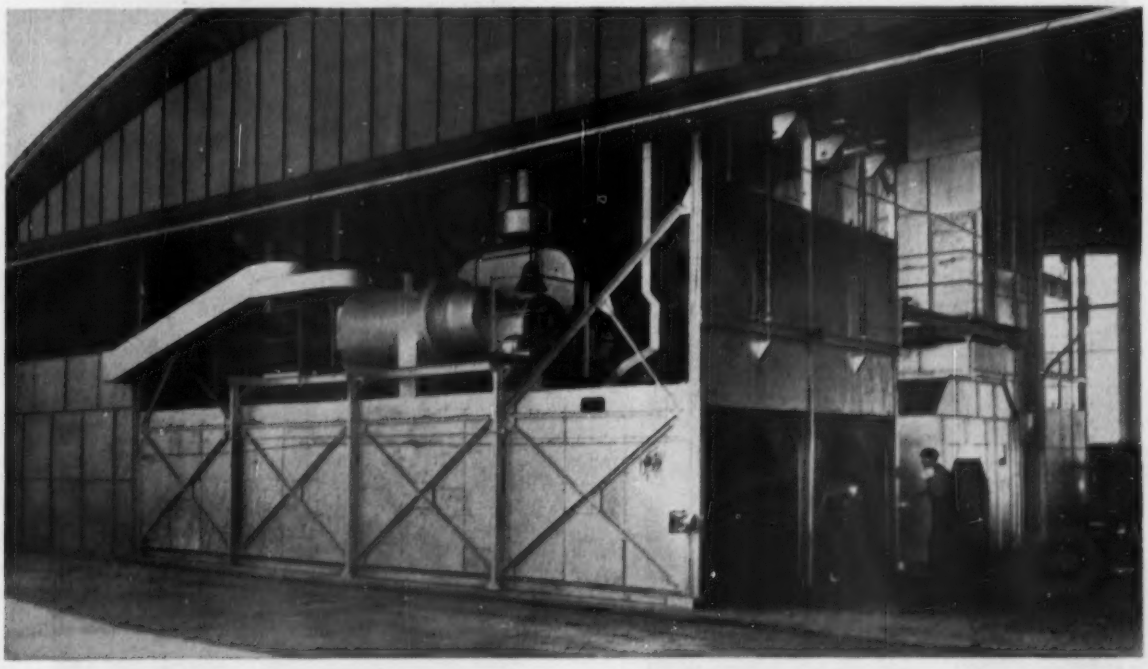


Fig. 1. General view of Perfectair synthetic paint plant for the two-litre Swallow Doretti

Fig. 2. The interior of the enamel oven

Fig. 3. The spray booth with entrance vestibule in background

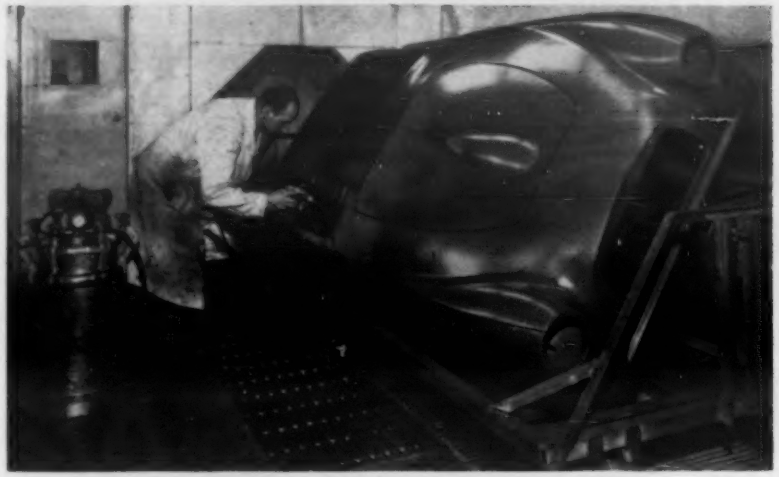


Fig. 4. The body is mounted on a spit truck for convenience of operation

Fig. 5. The exit vestibule with a body coming from the spray booth for stoving

accumulate.

Fig. 3 snows in the background a car body and truck about to enter the entrance vestibule. The paint spraying booth is in the foreground of this illustration. An interesting feature of this booth is that the air distribution is more in a diagonal direction, left-hand top to right-hand bottom, than is customary in the conventional down-draught type booth. This direction of air distribution is particularly desirable for operation in conjunction with the spit-type truck. The angle of paint spray remains constantly in one direction because the operator can bring the part to be sprayed into the most convenient position merely by rotating the body, which is pivoted at its ends, see Fig. 4. It will be noted that the operator does not need a mask. Consequently the over-spray is always directed towards the water-washed side of the booth; the cross current or air movement in the booth assists this.

Air is supplied through secondary filters arranged in the angled and horizontal ceiling of the booth. The filters are of the oil-impregnated scrim-covered replacement type. Fume and paint laden air is exhausted through scrubber tubes mounted in a horizontal opening in the water-washed back of the booth. The contaminated air is then drawn through a further paint-eliminating section before being discharged to the atmosphere.

The balance of supply and exhaust air in the booth is of great importance. Actually, less air is supplied to the booth proper than is exhausted from it. The make-up comes from the two vestibules, so that there is a constant infiltration of air from the vestibules to the booth. Of the total twelve c.f.m. air supply, eight c.f.m. go direct to the spray booth and two c.f.m. go to each vestibule. Of the air supplied to the entrance vestibule there is one c.f.m. spilled through the silhouettes, and one c.f.m. goes into the spray booth; similarly with the supply to the exit vestibule, one c.f.m. passes into the spray booth and one c.f.m. spills through non-return louvres. Exhaust from the spray booth is at the rate of ten c.f.m. Experience has shown that if this very fine air balance is not accurately maintained, the drift of air from the booth to the vestibule will cause paint "ghosting" on bodies which are receiving treatment either just prior to or subsequent to operations in the spray booth proper.

For delivery to the spray booth and the vestibules, air from outside the building is drawn through a primary air filter of the viscous automatic self-cleaning type. From the filter, the air passes through an indirect gas-fired pre-heater battery. This type of heater was installed because the factory heating plant was not capable of providing all the heat required for the fresh air make-up system. After passing through the battery the air is drawn through an air washer or humidifier to give the correct humidity conditions for the application of the synthetic enamel. A secondary heater served by the factory low-pressure hot water heating system is mounted at the outlet of the humidifier.

The prime mover for the air supply, namely the centrifugal double inlet fan, is connected to this heater battery. It delivers the air through the secondary air filter cells by a system of ducting into the spray booth proper and the entrance and exit vestibules. This arrangement ensures that air at known and predetermined temperature and relative humidity is supplied to these three zones at all times. Fluorescent lighting is provided in the spray booth and the vestibules. It is arranged behind glazed apertures, so designed as to give a flush face with the inside surface of the panelling. The light intensity in the entrance vestibule and spray booth is such as to give 40 ft candles at the surface of the work. This plant has been remarkably successful both for quality of work and economy of operation.

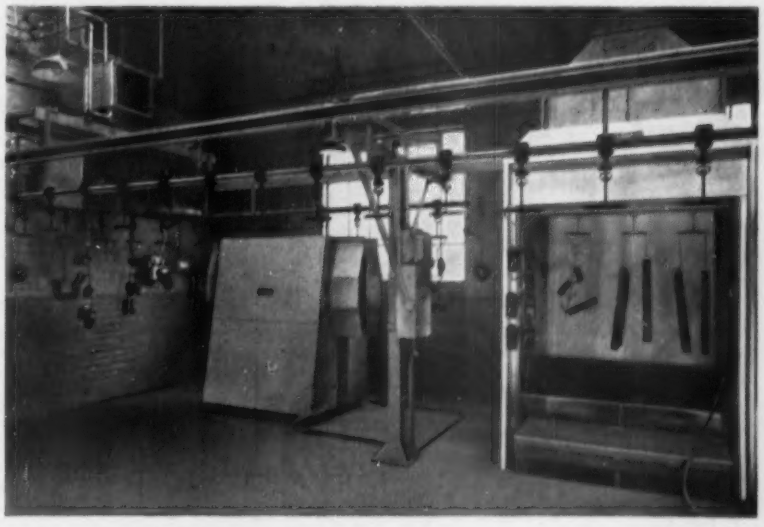
PAINT DRYING PLANT

Metrovick Infra-red Heating Installation for Finishing Small Machine Components

THAT infra-red heating can be used with advantage to accelerate finishing processes, even in relatively small plants, is demonstrated by the Metrovick equipment recently installed at the factory of Messrs. E. P. Barrus, of Acton. The components being treated are mostly grey or malleable iron castings for the Black Hawk power presses manufactured by the Company. An air-drying synthetic paint, specially compounded with appropriate solvents to meet the requirements of the installation by Trimite Ltd., is sprayed on the previously degreased and cleaned parts in a single heavy coat. No primer is used. The spray booth is hooded and an extractor fan draws off the fumes by way of ducting.

The conveyor is a standard Teleflex ·705 cable type running in a rectangular circuit approximately 27 ft by 7 ft. Track lines are supported at each end on wall brackets and at the centre by a transverse beam on a single stanchion on which is mounted the control gear. Hangers are arranged at intervals of 15 in and the work-holding jigs are rotatable through 360 deg. Drive is by a 1 h.p. motor and a belt reduction gear, giving alternative speeds of 12 in and 18 in per min. The weights of individual components range from less than 1 lb to 17 lb and the maximum loading per hanger is 21 lb. As regards dimensions a loaded hanger must pass through apertures 8 in. wide and 36 in high in the ends of the spray booth.

Divided on a vertical longitudinal plane, the oven is 6 ft long and each half is independently mounted on four castoring wheels. Thus it is possible to adjust the width of oven to accommodate the work and also to change its position in relation to the spray booth to vary the paint solvent "flash-off" time before the part enters the oven. Standard Metrovick infra-red tubular sheathed elements are used, having a maximum electrical loading of 31·8 kW. The equipment includes regulators to permit stepless variation of heat input. Controls are interlocked so that the conveyor can be run while the oven is switched off, but the oven can be switched on only when the conveyor is in operation.



Metrovick infra-red paint-drying oven at the works of E. P. Barrus, Ltd.

AUTOMOBILE FANS

A Rational Method of Design to Avoid Protracted Development Work

J. L. Koffman, Dipl.-Ing., M.I.Loco.E.

THE design of automobile fans scarcely presents difficulties once the fundamental dependencies have been recognized and the performance limits, set mainly by aerodynamic and noise considerations, are fully appreciated. Performance limits have already been studied[1], so this article deals only with a simple method of fan design, the effectiveness of which, for the type of application considered here, has been verified by a considerable number of practical applications. The importance of rational methods of fan design and performance prediction is becoming increasingly appreciated because of the difficulty of ensuring adequate engine cooling in the face of increasing outputs and current body design trends. Even so, in many instances, fans are still developed through successive approximations of the "twist it and try" variety of blade evolution, and often the results sought are fundamentally impossible.

Because of relatively large obstructions, in the shape of auxiliaries or the complete engine, encountered downstream of the fan in most instances, the values of pressure head against which the fan has to work must be based on a number of assumptions, the accuracy of which will affect the effectiveness of the resultant design. Furthermore, the magnitude of the pressure head is often influenced by subsequent changes in installation; this should be allowed for in the design stage and conservative estimates are called for when considering pressure values against which the requisite air flow will have to be maintained.

Flow conditions

Air approaches the fan blades axially at a velocity C_m ft/sec. This is obtained from $C_m = V/A$, where V is the air flow in ft³/sec, and A the effective fan area in ft², given by $A = (\pi/4)(D^2 - d^2)$ where D and d are respectively the blade tip and fan hub diameters, in ft. If U is the blade rotational velocity, in ft/sec, at any radius, the relative air velocity W in ft/sec is given by the vector sum of U and C_m, Fig. 1. The work done upon the air by the fan results in the air being deflected and leaving the fan at an absolute velocity C_2. The absolute air velocity and the velocity relative to the blade can be represented in a common diagram, Fig. 1, from which it will be noted that the conditions downstream of the fan, i.e. the pressure rise, will depend upon the magnitude of the whirl component C_u in ft/sec. This is given by $C_u = \Delta p/\eta\rho U$, where Δp lb/ft² is the total pressure rise through the fan; η, in decimals, is the total fan efficiency; ρ in lb-sec²/ft⁴ is the air density and U in ft/sec the blade velocity at the radius concerned. Since Δp should be constant over the entire blade length, whilst U is proportional to the radius, it follows that C_u is inversely proportional to the blade radius. If U, C_m and C_u are known, the magnitude of the mean air velocity past the blade chord is given by $W_\infty = \sqrt{C_m^2 + (U - C_u/2)^2}$ ft/sec, whilst the value of the angle β_∞ between U and W_∞ is determined from $\tan \beta_\infty = C_m/(U - C_u/2)$, Fig. 1.

The fundamental equation for blade size determination links the properties of the aerofoil sections with the blade chord length, pressure rise, fan speed, efficiency, air density, relative air velocity past the blade and the number of blades, that is,

$$C_L \times l = \frac{120\Delta p}{nzW_\infty \rho \eta}$$

where C_L is the dimensionless lift coefficient of the blade section, l the blade chord length in ft, z the number of fan blades and n the fan speed in r.p.m.

Determination of fan size parameters is appreciably assisted by making use of non-dimensional pressure and discharge coefficients $\psi = 2\Delta p/\rho U_t^2$ and $\phi = C_m/U_t$ respectively, where U_t is the blade tip velocity in ft/sec. Generally, simultaneous values of about 0·25 cannot be exceeded under the somewhat primitive installation conditions considered here[1]. The fan hub diameter, at a first approximation, is obtained from $d = D\sqrt{0{\cdot}8\phi}$. Furthermore, it is desirable to ensure that $l/t > 1$, where t is the blade pitch, thus blade overlap is avoided. Allowance

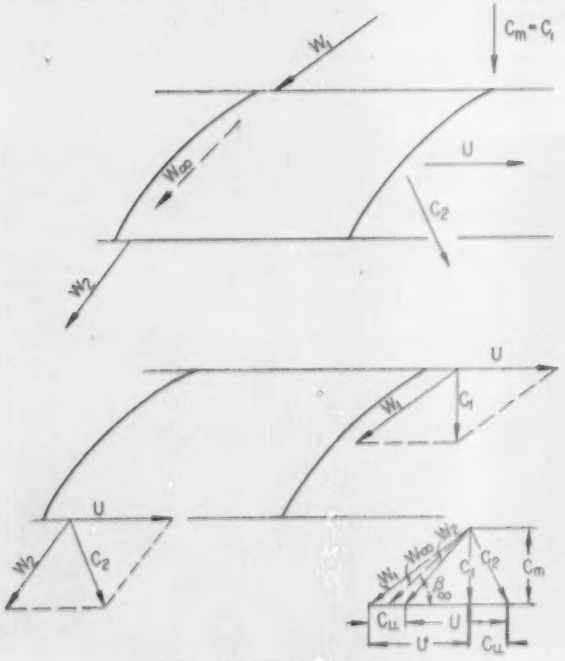


Fig. 1. Air flow through fan

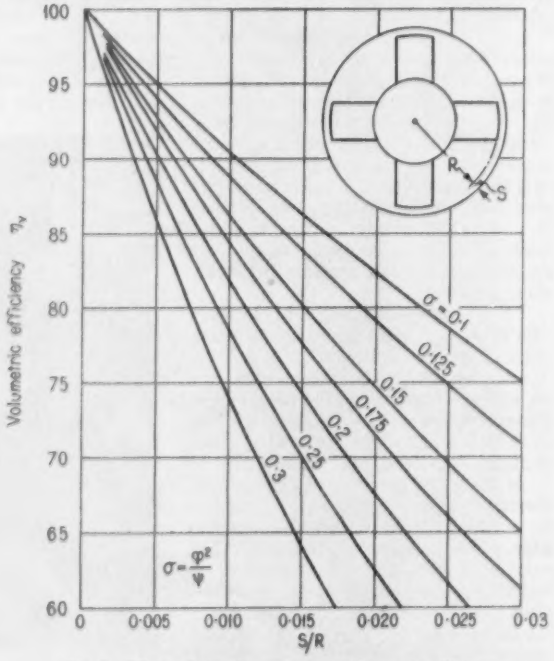


Fig. 2. Effect of tip clearance on volumetric efficiency

TABLE I. GOETTINGEN PROFILE DATA FOR PROFILES 436, 622, 623 624 and 625

X	436		622		623		624		625	
	Y_u	Y_l	Y_u	Y_l	Y_u	Y_l	Y_u	Y_l	Y_u	Y_l
0	2·66	2·66	2·40	2·40	3·25	3·25	4·00	4·00	5·50	5·50
1·25	4·53	1·21	3·75	1·45	5·75	1·95	7·15	2·25	9·00	3·30
2·5	5·54	0·79	4·50	1·05	6·45	1·50	8·50	1·65	10·80	2·35
5·0	7·00	0·37	5·45	0·60	7·90	0·90	10·40	0·95	13·80	1·25
7·5	8·11	0·15	6·16	0·35	9·05	0·35	11·75	0·60	14·95	0·75
10	8·98	0·05	6·60	0·25	9·90	0·20	12·85	0·40	16·35	0·40
15	10·16		7·30	0·15	10·95	0·10	14·35	0·15	18·25	0·15
20	10·82		7·70	0·05	11·55	0·05	15·30	0·05	19·30	0·10
30	11·08		8·00		12·00		16·00		20·00	
40	10·55		7·80		11·70		15·40		19·05	
50	9·60		7·10		10·65		14·05		17·35	
60	8·28		6·15		9·15		12·00		15·05	
70	6·60		5·00		7·35		9·50		12·10	
80	4·70		3·55		5·15		6·60		8·60	
90	2·64		1·95		2·80		3·55		4·75	
95	1·54		1·15		1·60		2·00		2·75	
100	0·43		0·20		0·30		0·50		0·65	

X = Distance along the chord from leading edge, per cent Y_u = Height of upper face of aerofoil, percentage of chord
Y_l = Height of lower face of aerofoil, percentage of chord

must be made for loss of flow due to recirculation through the gap between the blade tips and cowl. The values of fan volumetric efficiency are given by $\eta_v = V_1/V_2$ where V_2 is the flow through the fan and V_1 the flow downstream of the fan. These are plotted as a function of tip clearance/fan radius and the throttling coefficient v in Fig. 2. The values of total fan efficiency can here be assumed to be about 0·5 to 0·6, with 0·55 as a fair average.

Aerofoil performance data

The performance of a considerable number of aerofoils has been determined by the University of Goettingen[3] and the National Advisory Committee for Aeronautics, Washington.[2] The data of interest here are conveniently plotted in terms of lift coefficient C_L and gliding angle $\epsilon = C_D/C_L$, both as a function of the angle of incidence α. The lower the value ϵ the higher is the aerofoil efficiency. Performance data of circular arc aerofoils, as used with sheet metal fans, are plotted in Fig. 3. This shows that the best performance is obtained at $\alpha = 2$ deg. The C_L curves are parallel to each other over the most effective range, so that for camber/chord values of $f/l < 0{\cdot}1$, it is possible to determine lift coefficient values from

$$C_L = 9{\cdot}4\, f/l + 0{\cdot}094\alpha$$

The performance of a number of suitable Goettingen aerofoils is given in Fig. 4. Here, too, the shape of the curves is similar, so that for aerofoils 622 to 625 the C_L values, as determined by the ratio of maximum blade thickness/chord ratio, y_m/l, are given by:

$$C_L = 4y_m/l + 0{\cdot}092\alpha$$

For aerofoil 436, $C_L = 4{\cdot}4\, y_m/l + 0{\cdot}092\alpha$

These equations enable designers to determine the values of the lift coefficients for sections similar to the original profiles but with different thickness/chord ratios. The profile shape data are given in per cent of chord length l in Table I. A comparison of Figs. 3 and 4 shows that whilst the lowest ϵ-values with sheet metal and aerofoil type sections are similar, the range of minimum values is greater with the aerofoil type.

Fan size determination

With the help of the data already given, fan size can be determined. In the following example, the calculations are given for a 15·5 in diameter fan required to maintain a flow of 1,500 ft³/min at 2,100 r.p.m. against a total head, Δp, of 1 in water gauge (W.G.) = 5·2 lb/ft². With a blade tip speed $U_t = 142$ ft/sec and consequently a

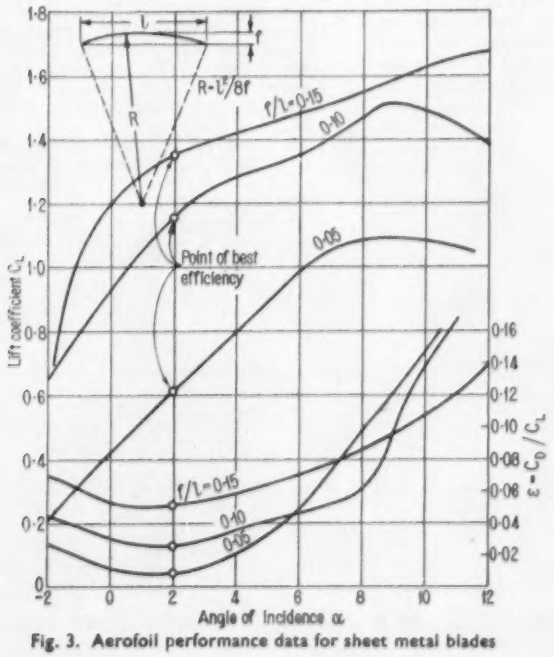


Fig. 3. Aerofoil performance data for sheet metal blades

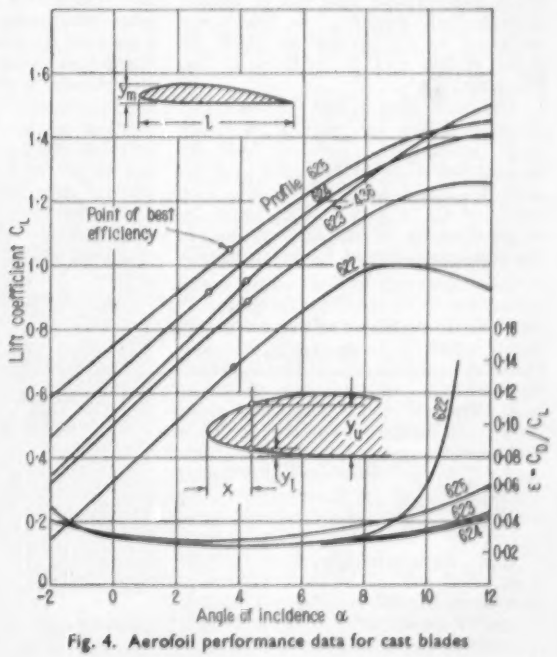


Fig. 4. Aerofoil performance data for cast blades

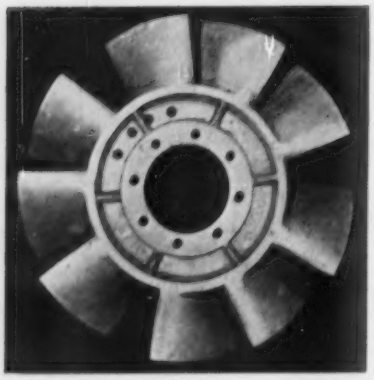


Fig. 5. Nine-blade fan with blades unevenly spaced to reduce noise

pressure coefficient $\psi = \frac{2\Delta p}{U_{tip}} = 0{\cdot}217$ (for air at N.T.P., $\rho = 0{\cdot}002378$ lb-sec^2/ft^4), $d = 15{\cdot}5\sqrt{0{\cdot}8 \times 0{\cdot}217} = 6{\cdot}45$ in. However, because of an existing hub cowl arrangement the hub diameter has to be increased to 9·5 in; the resultant effective fan area, A, becomes 0·8175 ft^2, so that the axial velocity, C_m, through the fan is V/A = 30·5 ft/sec. Consequently $\phi = 0{\cdot}215$, whilst the throttling coefficient is $\sigma = \phi^2/\psi = 0{\cdot}217$. For a tip clearance of S = 0·03 in and R = 7·75 in, S/R = 0·0039, a conservative estimate of the relevant volumetric efficiency is $\eta_v = 0{\cdot}95$, Fig. 2. Thus, with $V_1/V_2 = 0{\cdot}95$, the actual velocity through the fan will be $C_m = 32$ ft/sec.

Normally, fans should be designed to maintain a constant C_m over the entire blade length to avoid losses resulting from uneven distribution. However, in the present case the fan has to be mounted in front of numerous obstructions and since, because of noise considerations, a wider spacing at the blade roots is also desirable to permit uneven blade pitching, the blades are designed for C_m increasing from 25 ft/sec at the root to 39 ft/sec at the blade tip.

The chord length, and the angle β_∞ of the relative air velocity W_∞ are then determined. This is done by finding first $C_u = \Delta p/\rho\eta U$ (for $\eta = 0{\cdot}6$), then W_∞, and from this $C_L \times l$. The value of C_L at the root is given by implication by the requirement $l/t > 1$, the resultant value of C_L being chosen from the aerofoil data, Fig. 3 or 4. Since the value of C_u is reduced from root to tip, as the values of U and W_∞ increase, the value of the product $C_L \times l$ is also reduced from root to tip.

Here the designer can strike a suitable balance, and l usually is reduced towards the tip, mainly to keep the rate of change of blade angle low. Because C_m increases towards the blade tips of this fan, the chord has also been made to increase from root to tip. In this example it was decided to have nine blades; the decision was based on considerations of noise and hub axial length. The blade angles are finally determined from $\gamma_\infty = \beta_\infty + a$, where the angle of incidence a relative to the velocity vector W_∞ is obtained when choosing the value of C_L from Fig. 3 or 4. The calculations are carried out in the form as shown in Table III.

Blade sections are drawn by calculating and plotting the profile co-ordinates from the data in Table I.

TABLE II. CENTROIDS OF GOETTINGEN PROFILES

Profile Number	Distance from leading edge, per cent	Height from bottom of section, per cent
436	42·7	4·48
622	40·5	3·07
623	41·7	4·75
624	41·0	6·4
625	41·0	8·0

For example, at a radius of 5 in, l = 3·8 in = 100 per cent of the chord of profile 625. To avoid undue bending stresses resulting from centrifugal force, the blade sections should be arranged so that all centroids are on a common radial line. Tests have shown that the last 5 per cent of the chord at the trailing edge of aerofoil type blades can be removed without detriment to performance. This appreciably facilitates production, which might otherwise be made difficult by this rather thin portion of the blade. The results of tests carried out in a suitable tunnel are shown in Fig. 6, and are slightly better than those aimed at.

In the case of sheet metal fans required to work under conditions resulting in uneven velocity distribution

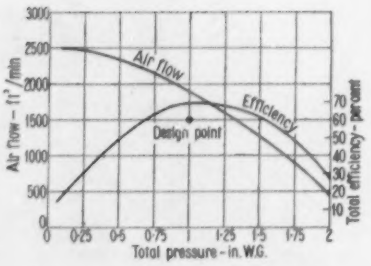


Fig. 6. Performance of nine-blade fan

downstream of the fan, it will often be desirable to increase the axial velocity C_m from root to tip. In these circumstances, production will be simplified by maintaining constant values of l and γ_∞ throughout, the actual values being determined, along the lines of Table II, for the mean value of C_m at the mean blade diameter d_m

$= \sqrt{(D^2 + d^2)/2}$ only.

The overall performance of fans can be appreciably improved by providing pre-swirl vanes ahead or straightener vanes downstream of it, or a combination of both. Additional improvement can be effected by the use of a suitably shaped hub nosepiece upstream and diffusor arrangement downstream of the fan. With carefully proportioned aids of this kind efficiencies of over 80 per cent can be obtained, together with pressure and discharge coefficient values at least twice as high as those of prevailing simple arrangements.

Acknowledgement is made to the Chief Scientist, Ministry of Supply, for permission to publish this article. Fig. 5 is Crown Copyright Reserved, and is reproduced by permission of the Controller, H.M. Stationery Office.

References

1. J. L. KOFFMAN, "Liquid Cooling," *Automobile Engineer*, February, 1954.
   B. ECKERT, "Neuere Erfahrungen an Überdruck - Axialgeblaesen," *Z.VDI*, Vol. 88, No. 37/38, September, 1944.
2. *Ergebnisse der A.V.A. Goettingen*, Vol. I-IV, R. Oldenburg, Munich, 1921-1932.
3. I. H. ABBOTT, A. E. VON DOENHOFF and L. S. STIVERS, "Summary of Aerofoil Data," *N.A.C.A. Report No.* 824, Washington, 1945.
   I. H. ABBOTT and A. E. VON DOENHOFF, *Theory of Wing Sections*, McGraw-Hill Book Co. Inc., 1949.

TABLE III. FAN DESIGN PROCEDURE

Radius, in	5	6	7	7·75
U, ft/sec	91·7	110·0	128·0	142·0
C_u, ft/sec	69·5	58·0	49·5	44·6
$U - C_u/2$, ft/sec	57·0	81·0	103·0	119·7
C'_m, ft/sec	25·0	30·0	35·0	39·0
$W_\infty = \sqrt{C'^2_m + (U - C_u/2)^2}$, ft/sec	62·2	86·5	107·4	126·0
$C_L \times l$	0·371	0·267	0·215	0·211
C_L (From Fig. 4)	1·21	0·8	0·615	0·583
Profile number	625	624	623	622
l, in	3·8	4·0	4·2	4·35
$\tan\beta_\infty = C'_m/(U - C_u/2)$	0·438	0·371	0·34	0·31
β_∞	23° 40′	20° 40′	18° 45′	17° 15′
a (From Fig. 4)	6°	1° 30′	1° 15′	2° 45′
$\gamma_\infty = \beta_\infty + a$	29° 40′	22° 10′	20°	20°

GOODS VEHICLE BODYWORK

New Materials and Techniques in Goods Carrying Bodies

ALTHOUGH it had been expected that the 1954 Commercial Show would reveal numerous advances in bodybuilding technique involving, in particular, widespread use of plastics materials, the actual direction of the advances caused some surprise. It had been thought that producers of bus and coach bodywork would be the first to use such materials as resin-bonded glass fibres to reduce the cost and difficulty of producing complicated panels. Instead, materials of this type, and other plastics, have been applied in several goods bodies, where useful savings in weight are appreciated. In addition, a welded, light-alloy integral lorry attracted considerable attention; in this vehicle several fabrication techniques hitherto unknown in the commercial vehicle field, are employed. Numerous manufacturers now have improved methods of employing interlocking light alloy extrusions in the construction of goods bodies.

The integrally constructed lorry mentioned above was designed and built by Mann Egerton and Co. Ltd., Norwich, in conjunction with the development department of the British Aluminium Co. Ltd., whose materials were used throughout. A measure of the success of this revolutionary design can be gauged from the fact that it is capable of carrying a payload of 8½ tons under the existing Construction and Use regulations, the unladen weight being slightly under 3 tons, so that it can legally be operated at 30 m.p.h. It is fitted with a Dennis, horizontal, six-cylinder, direct injection, 5·5-litre diesel engine located under the body slightly forward of the centre of the vehicle, with the cylinder head towards the off-side. A single dry plate clutch conveys the drive to a five-speed gearbox, and thence to a short propeller shaft and a two-speed axle. Other mechanical details of the specification are conventional, although the use of an aluminium alloy radiator, and a welded vacuum servo reservoir and 25-gallon fuel tank, both of BA 27 (NS5) material, undoubtedly contributes to the light weight of the complete vehicle.

Most of the structure is assembled by welding with Argonaut equipment except where thin sections and short runs make the use of Argonarc welding preferable. The underframe consists of two full length J-section longitudinals, 13 in deep and ¼ in thick. They are parallel throughout their length, the width of the underframe being 2 ft 11⅜ in. Ahead of the front axle the depth of the frame members is reduced to 8 in to lower the height of the cab floor and facilitate entry from the ground; they are also sharply cut away at the extreme rear, where the loading is less. The longitudinals are slotted to receive eleven full width cross members, formed of $\frac{3}{16}$ in thick angle sections. These, like the longitudinals, are of BA 27 (NS5) alloy. After the cross members have been located in position, flanges are welded on top of the longitudinals. These flanges are of ¼ in strip and maintain stress continuity throughout the underframe. Similar flanges are welded on top of the cross members to receive the floor. A folded, U-section cross member is used to support the rear engine mounting; two plates, between which is the rubber mounting, are welded on the outside of this section. Additional gussets are welded at similar points of stress concentration, such as over the spring hangers.

Forward bracket for the front spring of the welded, light alloy underframe of the Mann Egerton vehicle

Side raves, of BA 25 (HE10) material in the form of flanged channel section extrusions are bolted to the outer ends of the cross members so that they can be readily replaced if damaged in service. For the same reason the $\frac{3}{16}$ in thick BA 25 (HS10) P-G-P chequer plate floor is riveted on to the cross members. At the front, a stout headboard, framed in aluminium alloy angle sections and panelled in 14-gauge BA 355 (HC15) is riveted to the frame to protect the cab from the rear; a 16-gauge crash plate of the same material is welded across the front of the underframe under the cab floor. Both front and rear wings are of 16-gauge BA 60 (NS3) sheet. By using embossed panelling for the cab, and chequer plate wearing surfaces, the amount of painting required is reduced to a minimum, only the side raves and the headboard framing requiring such treatment. Brightwork on the cab and the front bumper are produced from super purity alloy extrusions electrically finished by the Brytal process.

Equally unusual is the light alloy tipper body produced by G. E. Neville and Son Ltd., Mansfield. This is assembled from a number of identical

Extruded aluminium alloy sections, pressed to U-shape, and bolted together, form the sides, floor and framing of this tipper body by G. E. Neville and Son Ltd.

Warerite self-coloured panelling, a glass fibre roof and wheelboxes and a laminated Melamine surfaced floor are used in this parcels van built by L. F. Dove, Ltd.

The front and rear mudguards of this Dodge 2-3 tonner are resin bonded glass fibre mouldings and the van body is panelled in Warerite

extruded sections, 9 in long, pressed to U-shape, jig drilled and bolted together to form the sides, floor and cross-bearers of a fixed-side body. It is 7 ft 2 in wide, and the length depends on the number of sections bolted together. The extrusions are in Noral 51 S.W.P. and weigh approximately 2·482 lb per ft. Each section consists of a flat plate with five transverse ribs, or feet, four of inverted T-section and the fifth with a plain end. This last rib is inset from the end of the plate, so forming a flange that fits into a recess above the end rib of the adjacent plate. The extrusion is $\frac{1}{8}$ in thick, and the ribs, which are $2\frac{1}{2}$ in apart, are $1\frac{7}{8}$ in deep.

The extrusions are sufficiently rigid to eliminate the need for conventional cross-bearers, and the depth saved, as compared with conventional bodies, can be used either to provide an exceptionally low floor height, or alternatively, exceptionally deep longitudinals. In the case of the body displayed at Earls Court, conventional depth channel section longitudinals are employed. They are attached to the body by triangular gusset plates by bolts and lock-nuts of the same size as those used in assembling the body sections. Channel section cappings are bolted on top of the body sides, and the tail gate and headboard comprise flat extrusions, as used in the main part of the body. These extrusions are bolted to angle section framing.

The total weight of the body displayed, excluding tipping gear, is 5 cwt 2 qr. Although shaping the extrusions to the required radius involves the use of carefully designed tools, the height of the body sides, normally $24\frac{1}{2}$ in, can be increased to suit specific requirements. Each 3 in added to the height of the sides increases the weight of each panel by $1\frac{1}{4}$ lb, and the capacity of the body by approximately 0·05 yd^3 per panel. A body 15 ft long, with a capacity of 8 yd^3, weighs 520 lb excluding longitudinals, gussets, etc. Light alloy mudguards are produced for attachment to the body; they weigh approximately 19 lb each, complete with stays. Loads from 250-300 lb per ft^2 can be accommodated by the body, which can be sealed to permit the carriage of sand or gravel, or even liquids, while the arrangement of the bolts is such that in the event of a panel suffering damage, it can be readily removed and replaced. Complete interchangeability is ensured by the employment of suitable jigs throughout. While this design represents an entirely original approach to the problem of the construction of tipping bodywork, it would appear to be adaptable to other types of body in which fixed sides and radiused corners are acceptable.

An equally unconventional van body for general goods haulage, where square corners are required to provide the greatest possible volume of usable capacity, has been built by University Commercials and Coachwork Ltd., and L. F. Dove Ltd., Croydon. This, as mounted on a Dodge chassis, can be employed for parcels carrying, and its capacity is 600 ft^3. The framework of heat-treated light alloy extrusions assembled with high-tension bolts and Simmonds nuts, is conventional. Entirely unusual, however, is the panelling. This consists of Warerite plastics material bonded to a wire-mesh matrix to form smooth, self-coloured flat sheets, which are riveted to the framing. The floor is a laminated material, combining impregnated plywood with a Melamine non-slip, ribbed surface finish. It should prove particularly resistant to damage resulting from packing cases being dropped on it. The front and rear mudwings of this vehicle are of polyester resin glass-fibre mouldings, as are the square wheel-boxes and the one-piece roof. Synthetic enamel used to finish the wings conceals their special features, but the wheelboxes and roof are unpainted, so that the interior is lit by the partly translucent roof.

Similar features are incorporated in an ultra-lightweight pantechnicon built on a Bedford 4-ton chassis by Arlington Bodybuilders Ltd. This vehicle has an extended wheelbase, and a forward control conversion, to enable a body with the exceptional capacity of 1,660 ft^3 to be fitted. The complete vehicle weighs under 3 tons. This result undoubtedly owes much to the use of a reinforced glass fibre roof, which is 27 ft 6 in long and 7 ft 6 in wide. The body framing consists of HE10WP heat-treated, extruded aluminium alloy sections riveted together, with side panelling of HS10WP aluminium alloy.

Flat, diagonal bracing strips are riveted to the framing at the front and rear to support the Luton extension and the rear overhang when loads are carried on the lowered tailboard. The floor is built up of this company's Huntalloy patent interlocking sections. Horizontal slats attached to the framing are shaped to receive felt inserts to protect the load. Other Huntalloy sections are used in an Albion drop-side lorry also displayed on this bodybuilder's stand. An interesting detail is the use of tubular framing for the drop-sides and tailboard. The side raves also consist of extrusions. These form rectangular tubes when assembled with the floor and are slotted at the appropriate points to accept the detachable centre posts of fabricated channel sections. A one-piece, resin-bonded, glass fibre roof is used for the cab of this vehicle.

A different application of this material is found in the new Reliant, three-wheeled 6-cwt van. The body of the vehicle is framed in hardwood. Resin bonded glass fibre panels are wrapped round the front and rear pillars and the waist rail before the plastics has set. The side panels, roof, and wheel boxes are bonded to the framing in this way; a noteworthy feature of this method of construction is that the timber is sealed as the material sets. Additional strength is obtained by incorporating recessed sections in the largest panels. The engine cover and propeller shaft tunnel are also formed of this material, which in these applications is screwed or pop-riveted to the adjacent timber framing and floor. In a vehicle of this sort, cost reduction rather than weight saving is the main object.

Neither of these considerations is the prime requirement for the design of dump trucks. A particularly robust example is the side-tipping, semi-trailer, quarry dumper that is manufactured by Eagle Engineering Co. Ltd., Warwick. The all-welded body is constructed mainly of mild steel. It is designed to carry a payload of 12 tons and to withstand the effects of grab loading. The body is 12 ft long, 9 ft 6 in wide inside, and the 2 ft deep sides slope outwards from the floor. Channel sections, 10 in by 3½ in, form the main longitudinals on which the body is based and the 8 in by 3½ in cross members spaced 1 ft apart. The sides and ends are framed in 7 in by 3½ in channels. Laminated construction has been adopted for the floor and sides: mild steel plates, ¼ in thick, are welded to the framing, and 2 in thick oak boards are laid on top and covered by a ½ in thick steel lining. At the ends the lining is ⅜ in thick. Roller type lifting lugs are attached to the top of the sides, because the body is devised to be tipped sideways by overhead tackle. This vehicle is intended for quarry use exclusively and could not be used on the road.

A special dumper designed for use on or off the road is supplied by Edbro—B. and E. Tippers Ltd. Built for the National Coal Board, the vehicle can carry a legal payload of 10 tons on the road; but is also capable of holding, without spilling, a 15 ton load of mine dirt when working off the road. The all-steel body is electrically-welded, and has a capacity of 10 yd³. Its channel section framing is clad with $\frac{7}{16}$ in thick plating, except in the case of the floor, which has ¼ in thick plating on top of a hardwood lining. The headboard is swept up to form a cab protecting canopy, and the rear of the body has a scowgate end at 30 degrees from the horizontal. In plan, the body is tapered from front to rear to provide improved load shedding during dumping, and its inside corners have a large radius of curvature.

The use of a scowgate end has called for unusual tipping arrangements. To overcome the initial adverse slope of the tail, a 70 degree angle of tip is essential. Because of this large angle, the body cannot return to its normal position under the influence of its own weight, so power lowering gear is also necessary. Twin, underbody, triple extension gear is used. The rams are mounted on a separate sub frame, which also carries the 12-cylinder swash plate type positive displacement pump. They have a double acting final extension for rapid lowering, and a restriction valve to prevent the body crashing down should a pipe be fractured as the body is being raised or lowered. A total time of 15 seconds is required to raise the body to the maximum angle of tip, the return time being 14 seconds. A scraper blade, controlled by hydraulic pistons, is attached to the front of the chassis, to enable the vehicle to clear a path on rough ground.

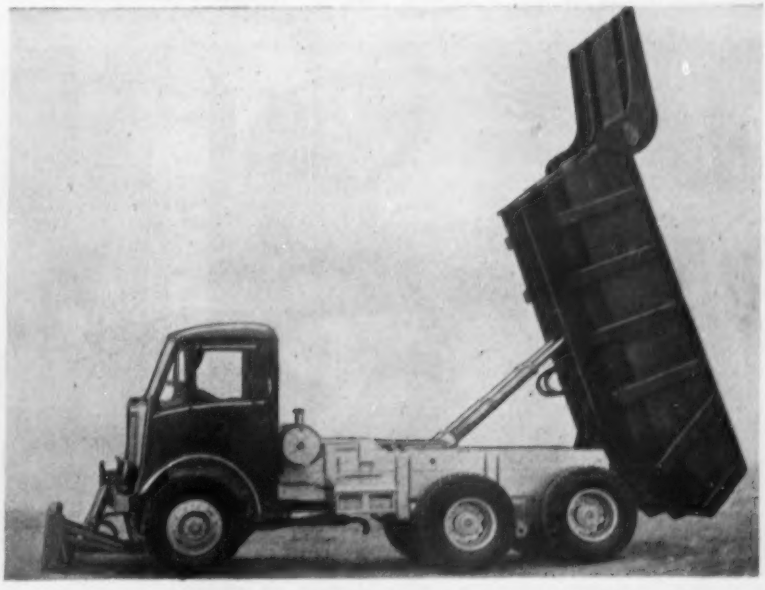
Another body built for the National Coal Board is supplied by Bonallack and Sons Ltd. This, however, is constructed of light alloys, and is of 11 yd³ capacity. The body is designed to withstand loading of the largest grades of coal from a 14 ft high hopper. It has framing fabricated from channel and angle section extrusions to which ⅛ in thick light alloy panelling is riveted. The corners of the body are radiused, and the floor is built up of Dekaloy patent interlocking flooring, laid longitudinally with timber inserts. The tops of the side panelling, and the tailboard, which is hung on overhead stumps with reinforced eyes, are protected by deep angle section rails. A tumbler type locking rod is used to keep the tailboard in position. This type of device is also used in drop-side bodies built by the same manufacturers, and an example was displayed on the stand. Compared with the conventional slotted pin and tongue, the Bonallack design has the advantage of positive location, the tongue being incorporated in the end of the tumbler.

Other bulk load carrying vehicles in which specialized requirements dictate structural design, are the tankers. Recent modifications of the regulations covering the transport of volatile liquids have resulted in the appearance of 4,000 gallon tankers, whereas until this year the maximum permitted in one tank was 3,500 gallons. Darham Industries (London) Ltd. are among the tanker builders who manufacture vehicles built to conform with the latest regulations. This is a five compartment, elliptical design, of mild steel. It has triple dished reinforced division plates, forming the framing of the tank shell, which is fabricated from 12-gauge mild steel. The recessed walkway at the top leading to the compartment caps is built integrally with the tank. Expanded aluminium sheet forms a non-slip tread plate in the walkway, and the mounting ladder is also of light alloy to eliminate the possibilty of sparking when struck by steel nails in boots.

The shell is mounted on two longitudinal beams, of rectangular tubular section, designed to accommodate two 20 ft lengths of 3 in hose. These beams are attached to the chassis by U-bolts over packing pieces. The front and rear packing pieces are insulated from the frame by rubber inserts, while the centre one is in direct contact with the frame. Complete with an Atkinson eight-wheeled chassis, the vehicle weighs 8 tons 9 cwt unladen, so that the laden weight, with a full load of petrol, is some 5 cwt within the maximum permissible gross weight for this type of vehicle.

A special feature of the aluminium tanks produced by A.P.V. Co. Ltd. is the method of tank mounting. Both 4,000 gallon and 2,000 gallon tanks supplied by this company have this system of mounting, in which four cast Alpax bearers are used. These are shaped to fit the radius of the tank, which they cradle. Alpax brackets are bolted to the chassis frame; these and the bearers have bosses formed in their ends, those in the bearers carrying Silentbloc bushes. A tube is passed through the Silentbloc bushes and the bearer bosses, and castle nuts are assembled on to each end. The A.P.V. 4,000 gallon tanker on a Maudslay Mammoth Major eight-wheeled chassis weighs 7 tons 14 cwt unladen, thus permitting 4,000 gallons of liquids, up to a specific gravity of 0·783, to be carried within the legal weight limit.

Despite the increasing use of light alloy and steel for the framing of commercial vehicle bodies, composite construction continues to offer advantages especially in the construction of special purpose vehicles of the one-off type.



A laminated steel and timber body is used in this tipper designed for use on open cast coal mining sites. The body and tipping gear were built by Edbro—B & E Tippers Ltd.

Many of these are mobile shops, in the design of which ingenuity is required more in the arrangement of the interior than in the structural details. One unusual vehicle has been made by Kennings Ltd. This is an insulated and refrigerated milk container mounted on a Morris-Commercial J-type chassis.

The body is mounted separately from the cab on the chassis, and is framed in hardwood. Its exterior panelling is 20-gauge sheet steel, and galvanized steel panels are used for the interior lining. A 2 in thickness of Fibreglass insulation is packed between the skins. In the centre of the body, immediately behind the cab, is installed a Prestcold Presmatic refrigeration unit. This incorporates a ½ h.p. electric motor and a twin cylinder compressor. Suspended from the roof of the container is a Winget Dole, eutectic plate, 5 ft long by 2 ft 6 in wide by 2⅜ in thick. Overnight running of the condenser provides a hold-over capacity sufficient to maintain a temperature of 40 degrees F inside the body for eight hours without recharge. Accommodation for a load of crated milk bottles is arranged on three levels inside the body. To accomplish this, the floor has been arranged above the wheel boxes; the arrangement also allows the load to be placed around as well as on top of the refrigeration unit.

Another bodybuilder using composite construction to good effect is B. Walker and Son Ltd. The advantages of both steel and timber are fully utilized. For example, a vehicle comprising a 555 ft³ body on a Commer forward control 25 cwt van weighs under 2 tons. The main framing is of welded steel channels with hardwood inserts to carry the Plymax exterior panelling. Rolled steel channels are employed for the roof framing, and they are panelled with 22 gauge sheet steel. The rear of the body is enclosed by a steel framed tailboard and by a roller shutter. Tongued and grooved ⅞ in softwood, to which the steel wheel-boxes are attached, is laid for the flooring.

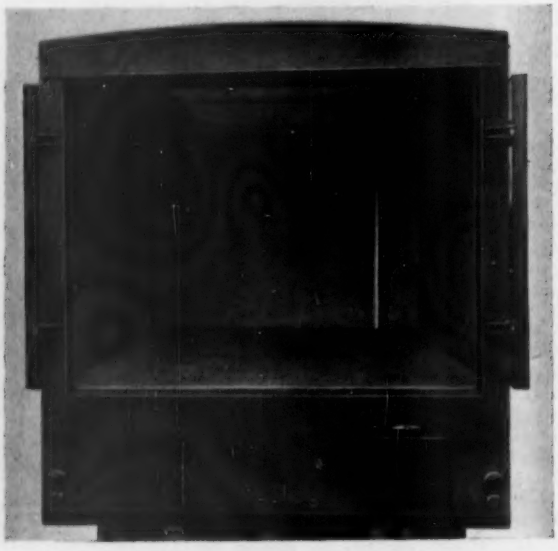
A refrigerated milk container body, mounted on a Morris Commercial 10 cwt chassis. The body was built by Kennings Ltd.

A Luton van by J. H. Sparshatt and Sons Ltd. on a Dodge chassis has a patent loading arrangement developed by the bodybuilder: the rear half of the roof is designed to slide forward, over the front half, on rollers in special tracks built into the body sides beneath the cant rails. Overhead loading, by means of a crane, can thus be employed when dealing with heavy goods. The sliding section is actuated by two synchronized electric motors and chains.

New designs of light vans, with payload capacities of 5-6 cwt are worthy of careful study. Among the latest are the Austin and Ford 5 cwt vans, and the Standard 6 cwt van and pick-up. All three are of pressed steel integral construction, in which the underframe, and many of the body pressings, are similar if not identical, to those used in the private car structures from which they are developed. Both the Austin and the Ford have a roof line that is level from the top of the windscreen to the rear doors, while the Standard roof is stepped-up behind the cab.

In the case of the Ford, the one-piece roof pressing, which is deeply swaged longitudinally, incorporates both the screen framing and the valance between the bottom of the screen and the forward edge of the main scuttle pressing. The design of the body, which follows the style of the Anglia and Prefect saloons, benefits from the use of full-length wings. These stiffen the side panels.

The new Thames 5 cwt van has an all-steel body with a capacity of 66·5 ft³



Interior of a refrigerated milk container body built by Kennings Ltd., and mounted on a Morris Commercial 10 cwt chassis

EXHAUST SILENCING

The Tuning of Exhaust Systems to Improve Noise Reduction

F. J. H. Tutt, B.Sc., G.I.Mech.E.

INADEQUATE exhaust silencing of internal combustion engines is still a fairly common fault despite the acoustic efficiency of modern silencers. It is not always realized that in many instances simple and inexpensive modifications may be carried out to make a worthwhile reduction in noise. These modifications entail little additional back pressure and only a small increase in weight; moreover the space requirements are relatively easily met. The changes involve repositioning the silencer in the exhaust system and in some cases, where this cannot be done, in altering the length of the exhaust piping.

The exhaust noise from an internal combustion engine normally consists of an irregular waveform, which is repeated at a frequency equal to the firing frequency of the engine, that is:

$N \times \frac{n}{2}$ c.p.s. for a four stroke engine

and $N \times n$ c.p.s. for a two stroke engine, where N is the number of cylinders and n is the engine speed in revolutions per second. Therefore, the noise may be assumed to consist of a basic component equal to the engine firing frequency, plus a number of components having frequencies equal to integral multiples of the basic one. The number and importance of these components may be calculated from a Fourier analysis of the complex waveform. This waveform can be determined from pressure measurements in the exhaust manifold. Early theoretical work carried out by Kluge[1] assumed that the exhaust pressure fluctuations formed a square wave, which was separated into its components by Fourier analysis.

If the frequency of any of the pressure components in the wave coincides with a resonant frequency of any part of the exhaust system, standing waves or resonant vibration will be set up. Consequent amplification of the pressure components produces increased exhaust noise and tends to reduce the efficiency of the silencer. The natural frequencies of the various sections of the exhaust piping can be found in a similar way to those of organ pipes, but with certain simple modifications. The characteristics of the pressure fluctuations also are similar to those in organ pipes.

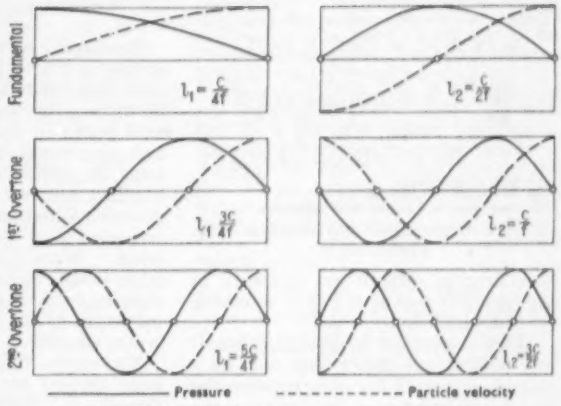


Fig. 1. Modes of vibration of sound waves in pipes

It may be assumed that there is a node in the pressure waves at each end of an open ended pipe when it is in resonance: that is, the pipe must contain an integral number of half wavelengths, and

$$l = \frac{n\lambda}{2}$$

where l is the length of the pipe, ft, λ is the wavelength of the sound, ft, and n is any integer. The wavelength of the sound is given by

$$\lambda = \frac{c}{f}$$

where c is the velocity of sound, ft/sec, and f is the frequency of the sound. Combining these two equations gives

$$f_n = \frac{nc}{2l}$$

for the natural frequencies of the pipe.

For a pipe closed at one end, at resonance there must be a node in the pressure wave at the open end and an antinode at the closed end: that is, there is an odd number of quarter wavelengths, and

$$l = \frac{m\lambda}{4}$$

where m is any odd integer. Therefore, the natural frequencies are given by

$$f_n = \frac{mc}{4l}$$

The resonance or standing wave patterns for the two types of pipe are shown in Fig. 1. In addition, the particle velocity distributions are plotted and show that when the pressure is a maximum the velocity is zero and *vice versa*.

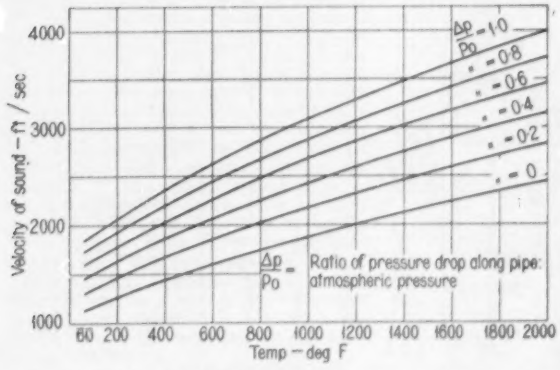


Fig. 2. Variation of sonic velocity with pressure and temperature drop

It has been assumed in the preceding work that the sound was perfectly reflected at the open ends of the pipes and that the nodes lay exactly in the planes of the openings. If this were the case no sound energy would be radiated. In fact, however, the node lies a small distance outside the pipe, so it is necessary to apply a correction when equating the pipe length to the length of the sound wave at resonance. This correction is the equivalent of a small addition to the pipe length, and it slightly reduces the natural frequency. For a pipe open at both ends,

$$l_e = l + 2a$$

where l_e is the effective length and a is a constant for any given pipe, but depends upon the pipe diameter and the end conditions. If the pipe is closed at one end,

$$l_e = l + a$$

For a pipe of radius R, terminating in a flange of infinite diameter, Rayleigh[2] suggests $a = 0{\cdot}82\,R$, whereas for a pipe with a simple open end[3], $a = 0{\cdot}61\,R$. An empirical equation[4] gives

$$a = 0{\cdot}60 + 0{\cdot}22\,e^{-\frac{KR}{W}}$$

where W is the flange width and K is a constant having a value between 0·129 and 0·136.

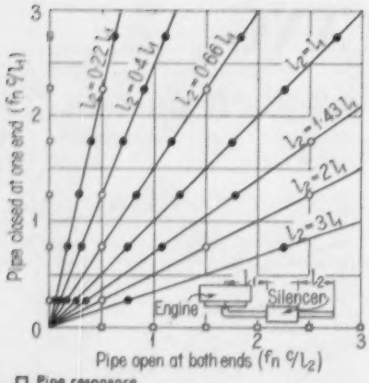
The velocity of sound is given by

$$C = \sqrt{g\gamma RT}\,.\,X$$

where g is the gravitational constant, $\gamma = \frac{C_p}{C_v}$, R is the universal gas constant and T is the absolute temperature. The factor X is determined from[5]

$$X = \frac{2}{\gamma - 1}\left[\frac{\gamma + 1}{2}\left(1 + \frac{\Delta p}{p_o}\right)^{\frac{\gamma - 1}{2\gamma}} - 1\right]$$

where Δp is the pressure drop along the pipe, and p_o is the atmospheric pressure. The manner in which the velocity of sound varies with temperature and pres-



□ Pipe resonance
● Resonance in l_1 blocked by l_2
○ Resonance in l_1 amplified by resonance in l_2

Fig. 3. Resonant conditions of exhaust pipe combinations

sure drop in exhaust gas is shown in the family of curves of Fig. 2, assuming a value of 1·3 for γ.

Work carried out by Martin, Schmidt and Willms has shown that only by a suitable choice of the ratio between the length of exhaust pipe between the engine and silencer and that of the pipe behind the silencer can the optimum noise reduction in the exhaust system be obtained.[6] It has been shown in the foregoing that the resonant frequencies of a pipe closed at one end are given by

$$f_n = \frac{1}{4}\cdot\frac{c}{l}, \frac{3}{4}\cdot\frac{c}{l}, \frac{5}{4}\cdot\frac{c}{l}, \frac{7}{4}\cdot\frac{c}{l}, \text{ etc.}$$

and those of a pipe open at both ends by

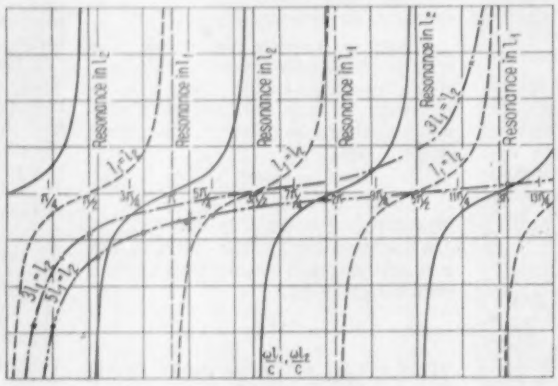
$$f_n = \frac{1}{2}\cdot\frac{c}{l}, \frac{c}{l}, \frac{3}{2}\cdot\frac{c}{l}, 2\cdot\frac{c}{l}, \text{etc.}$$

The perfect exhaust silencer has not yet been invented and it is therefore inevitable that some of the sound produced in l_1, Fig. 3, will be transmitted through the silencer to l_2. When the frequencies of any of the components present in the exhaust noise coincide with the resonant frequencies of l_1, standing waves are set up, the sound is amplified and more of it passes through the silencer to l_2. It is obviously undesirable that this sound should be further amplified by standing waves in l_2. Owing to the impulsive nature of the exhaust noise and the large number of components of different frequencies present in it, resonances in the exhaust piping are unavoidable. However it is possible to choose the lengths of l_1 and l_2 in such a way that none of their resonances occurs at a common frequency.

The coefficients of $\frac{c}{l}$ in the above equations are shown plotted as ordinate and abcissa respectively in Fig. 3. In this illustration, the lines radiating from the origin show the conditions existing in an exhaust system for various pipe length ratios. When resonances in l_1 and l_2 occur at the same frequency, the amplifying condition is shown by an open circle. When there is no resonance in l_2 to coincide with one in l_1, the resonance in l_1 is blocked; this condition is shown by a black circle. It can therefore be seen that, of the values shown in Fig. 3, all resonant frequencies are blocked only for $l_2 = l_1$, $l_2 = 3l_1$ and $l_2 = 5l_1$.

Resonance curves for l_1 and l_2 are shown in Fig. 4, from which it can be seen that when $l_2 = l_1$ resonances in l_2 lie midway between those in l_1 and at zero points in the l_1 resonance curves, and *vice versa*. This therefore represents the optimum blocking obtainable between the two pipes, for when the pressure vibrations are a maximum in one pipe they are a minimum in the other. When $l_2 = 3l_1$, $5l_1$ and for all other length ratios, some at least of the resonances in l_2 do not occur at zero values for l_1 and the blocking therefore is less effective.

To verify this theory, some tests were carried out at the Ministry of Supply, F.V.R.D.E. The results are shown in Fig. 5. Noise measurements were carried out on a small generating set driven by a four cylinder, four-stroke petrol engine. When running under maximum load at 3,000 r.p.m., the silencer fitted with a short tail pipe was not very effective in suppressing the basic exhaust frequency of $3{,}000 \times 4/2 \times 1/60 = 100$ cycles/sec. It was not possible to vary l_1 without major modifications to the installation, so it was necessary to increase l_2 and hence the overall length of the exhaust system. From Fig. 5 it can be seen that by increasing the ratio of $l_2 : l_1$ from 1:5 to 6:5 in a series of intermediate steps, the exhaust noise was reduced by about 10 db. The space available in the installation did not permit the use of length ratios greater than 6:5; but from the results obtained, a length ratio of approximately 4:5 was considered to be the most satisfactory.


Resonance in l2
Resonance in l1
Resonance in l2
Resonance in l1
Resonance in l2
Resonance in l1
3l1=l2
l1=l2
3l1=l2
5l1=l2
l1=l2
3l1=l2
5l1=l2
l1=l2
3l1=l2
5

CURRENT PATENTS

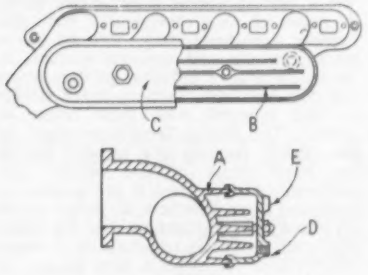
A Review of Recent Automobile Specifications

Liquid-cooled exhaust manifold

LIQUID cooling is applied to an exhaust manifold in a manner that does not unduly complicate the manifold casting. Although the position of the coolant chamber is not specifically defined, it is preferably located at the hottest area of the manifold in order to lessen the possibility of the exhaust gases being cooled to dew point and tending to lead to corrosion.

The manifold is formed with a continuous outstanding flange A and, within the area enclosed by the flange, several longitudinally disposed integral fins B. The central fin is bossed to receive two studs by which the demountable cover C is attached. Fluid tightness is ensured by packing material carried in the bifurcated margin of the cover and by cap nuts on the studs. Inlet and outlet ports D and E respectively are provided at opposite ends of the cover.

In alternative constructions flange A and fins B may be separately produced and welded or brazed to the manifold;



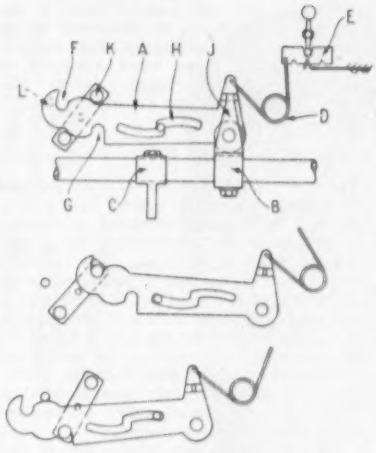
No. 707603

fins may be provided on the inner surface of the cover; and the coolant may be arranged to flow serially instead of in parallel between the fins. *Patent No.* 707603. *Imperial Chemical Industries Ltd.*

Gear preselection mechanism

PRESELECTION and engagement of either of two gears is effected by a latch lever which is preloaded to rock by means of a hand-operated selector lever and linearly moved to engage the gear on the release of the clutch control pedal. The latch lever A is pivoted on a fork B secured to the normal selector rod carrying the usual gear fork C. An arm on the latch lever is coupled by a hairpin spring D to a gear lever block E positioned by a cantilever spring detent. At its opposite end the lever is formed with latch notches F and G and adjacent cam surfaces. Movement of the lever is limited by a slot H engaged over a pin mounted in the gear housing, and a cantilever spring detent J tends to hold the lever in its neutral position. A double crank member K mounted in the gear housing and connected with the normal clutch withdrawal mechanism is turned anti-clockwise to a stop L on depression of the clutch pedal and clockwise, on release of the clutch pedal, by a return spring, not shown.

In the neutral position shown in the upper diagram the crank K moves over



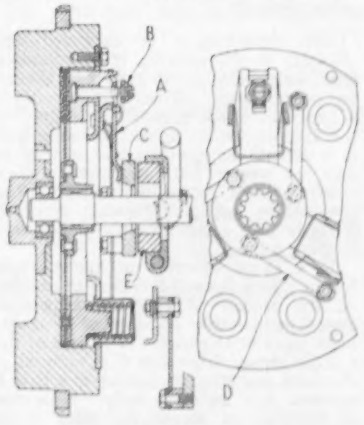
No. 707764

the cam faces of the lever on depression or release of the clutch pedal and there is no tendency for the lever to rock and engage. If the gear block E is moved to the right, spring D is constrained to raise the free end of the lever and to engage notch F on the crank member K when the clutch pedal is depressed. As the clutch pedal is released the latch is moved to the right, as shown in the second diagram, to effect a gear engagement.

If the gear block E is moved to the left to preselect the other gear, spring D tends to depress the free end of the lever so that notch G engages the crank K, and the gear is engaged when the lever is moved to the left, as in the third diagram. *Patent No.* 707764. *Austin Motor Co. Ltd.*

Clutch actuation

TO obviate the transmission of undesirable transverse forces to the pivots of clutch actuation levers, the withdrawal ring engaging the lever ends is mounted to rotate with the flywheel by means of tangentially arranged flat spring links. In an otherwise conventional clutch dis-



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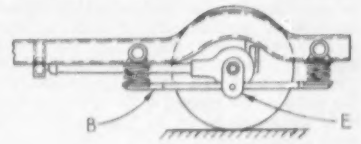
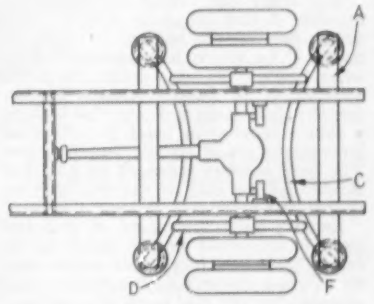
engagement is effected by means of three pressed-steel radial levers A fulcrummed on the flywheel cover plate and operating against bolts B in the presser plate. Engaging the radially inner ends of levers A is a cast iron ring C connected to the flywheel cover plate by three spring steel links D.

When the carbon ring E is moved by the operating fork into engagement with ring C, a torque is exerted on the ring tending to decelerate its motion relative to the flywheel. This force is resisted by the links D, the levers A are relieved of any transverse forces, and wear and noise ascribable to such forces are eliminated. *Patent No.* 707355. *S.A. Française du Ferodo* (*France*).





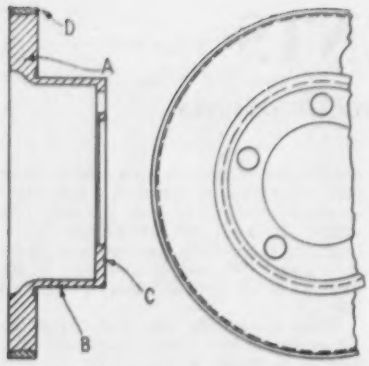
No. 708068

Rear suspension

BY suspending from a rigid rear axle a substantially rectangular auxiliary frame it becomes possible for the metal or rubber springs interposed between the auxiliary frame and the chassis frame to be disposed in or beyond the planes of the road wheels. The springs are relieved of driving and braking stresses by a torque tube enshrouding the propeller shaft and of transverse stresses by a guide or guides between auxiliary frame and chassis.

In the example the four springs are mounted at the ends of transverse chassis members A spaced equidistantly fore and aft of the axle centre. To these is attached the auxiliary frame B comprising bowed transverse members C joined by parallel longitudinal members D. The auxiliary frame is suspended from the axle by a pair of links or shackles E. Transversely, the auxiliary frame is guided by rollers in guides F mounted on the chassis side members. As an alternative a single roller and guide may be fitted at the rear between members C and A. To provide a measure of resilience at these guides the roller or rollers may be furnished with rubber tyres.

The specification shows diagrammatically a number of variant constructional arrangements. *Patent No.* 708068. *Bela Barenyi* (*Germany*).



No. 708083

Brake disc

WHILE cast iron brake discs are more economical to produce than steel discs they are less stable. When subjected to rapid heating and cooling under service conditions, surface cracks may appear and subsequently join up with one another. These tend to deepen and in time may lead to a partial disintegration. To reduce this hazard on a cast iron disc it is proposed to fit to the periphery a steel band.

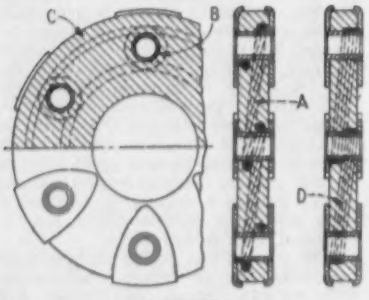
The brake disc comprises an annular member A cast integrally with a cylindrical member B having an inturned flange C by which it is secured to the wheel hub. At its outer periphery member A is formed with a shallow concave depression and over this is fitted a thin endless steel band D having an inner periphery of complementary shape. The band may be expanded by heat and shrunk on the disc or the disc may be chilled and contracted to enter the band.

Relative axial movement of disc and band is prevented by the shape of the fitting surfaces. Alternative means may be to peen the edges of the band over chamfers on the disc or to fit a shallow-flanged band over a recessed disc. Relative angular displacement is precluded by radial pegs fitted through the band and into the disc. *Patent No.* 708083. *Dunlop Rubber Co. Ltd. and H. J. Butler.*

Transmission coupling disc

IN this flexible coupling disc the torque is transmitted by closed wire loops A engaged over adjacent coupling stud bushes B. Each loop is made from a continuous length of multi-strand wire wound over itself to form, in effect, a wire grommet. The inner peripheral length of each loop is greater than twice the linear distance between adjacent stud centres plus the circumference of one stud bush. Thus, when embedded in the moulded rubber disc C, they are arranged to follow the curvilinear path concentric with the disc which is the essential feature of the coupling.

Each loop is assembled to lie in a plane inclined with respect to the faces of the disc by mounting on the stud bushes above and below preceding and succeeding loops. Helically wound loops D are an alternative form, as described in an earlier patent specification, No. 696719, in which the loops were arranged in alternate parallel planes. *Patent No.* 707524. *Pirelli Societa Per Azioni (Italy).*

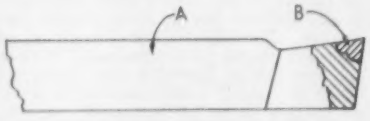


No. 707524

Diamond-tipped tool

IN the manufacture of diamond-tipped tools in which the cutting part is constituted by a single diamond, a number of difficulties are encountered in mounting the stone in the tool. The diamond requires to be secured in position in such manner that it cannot break loose during use and, as a rule, it is desirable that it can be reground in position. Should it be necessary to remove the stone for regrinding, it may suffer from the operation and particular care is demanded in resetting. In some cases subsequent processing will be required.

The invention lies in the use of bell metal for the tool body. This alloy, consisting of 76 to 83 per cent copper and 17 to 24 per cent tin, has the relatively low melting temperature of about 750 deg C, so the diamond is not injured when being set. Furthermore, it has a suitable contraction factor and on cooling the diamond is rigidly secured.



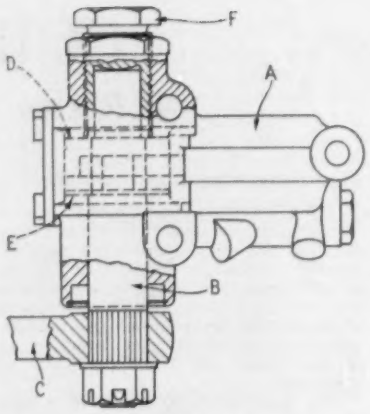
No. 707780

The tool body A is cast in a mould in which the diamond B is positioned so that it will be partly embraced by the alloy. It has been found that with this method of mounting the diamond can be reground without removing from the tool body. A lathe tool is illustrated but it is stated that milling cutters can be made in a similar manner. *Patent No.* 707780. *N. V. Philips' Gloeilampenfabrieken (Netherlands).*

Independent wheel suspension adjustment

THE development of excessive end play in the spindles of independent front suspension units can give rise to noise and shock. Where the spindle of a hydraulic shock absorber is utilized as the spindle for an upper wishbone arm it is difficult to eliminate end play or to take up wear. By the provision of a screwed thrust plug this disadvantage is obviated in such arrangements in which a single arm constitutes the upper suspension arm.

In a shock absorber of known type, having superimposed cylinders in housing A, the spindle B carrying suspension arm C is normally end-located by transaxial faces at D and E. The end of the spindle remote from arm C is reduced in diameter and takes its bearing in a plug F screwed into the main body. A locknut is provided to secure the plug in its adjusted position.



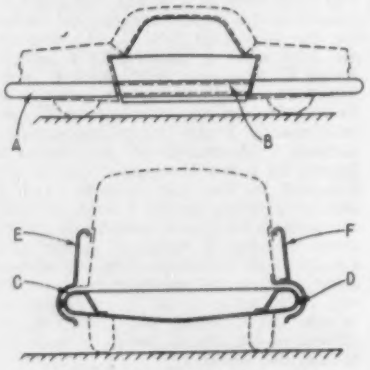
No. 707822

Should end play develop the clearance is taken up by confining the spindle between its end and face E. The base of the plug bore may be convex, as shown, and co-operate with the flat end of the spindle, or *vice versa,* or both parts may be of convex form. *Patent No.* 707822. *Austin Motor Co. Ltd.*

Ring-form bumper

IN a vehicle having a protective girdle encircling the bodywork, the ring bumper comprises bow sections A at front and rear and separate sections B, of the same or a different profile, across the door openings. Sections B are carried by and movable with their respective doors. The longitudinal members C of the chassis framing are located outside the track width of the vehicle and, preferably, the sections B are profiled to enshroud these members, as shown in the cross-sectional illustration. At the lower edge the section is stiffened by a return bend which serves as a drip flange. A resilient strip D secured to the inner surface of the section closes tightly against member C to seal the bottom of the door opening.

Section B may be formed integrally with the door E, as on the left or, alternatively, may be a separate member attached to the door, as on the right of the illustration. In the second case dissimilar materials may be used; for example, the door F may be of a synthetic material and the bumper section of metal. The means of attachment may be such as to facilitate removal and replacement in the event of damage. *Patent No.* 707627. *Daimler-Benz A.G. (Germany).*



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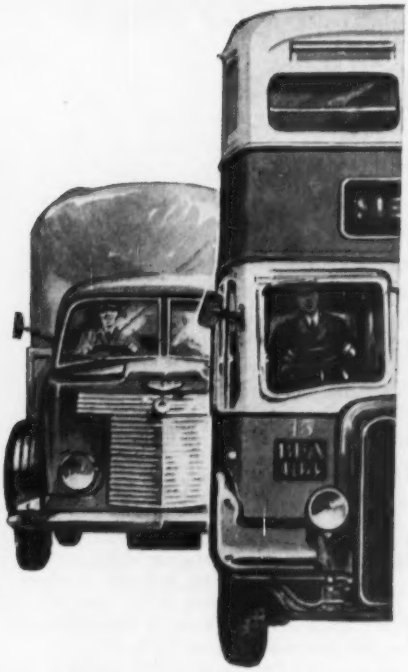

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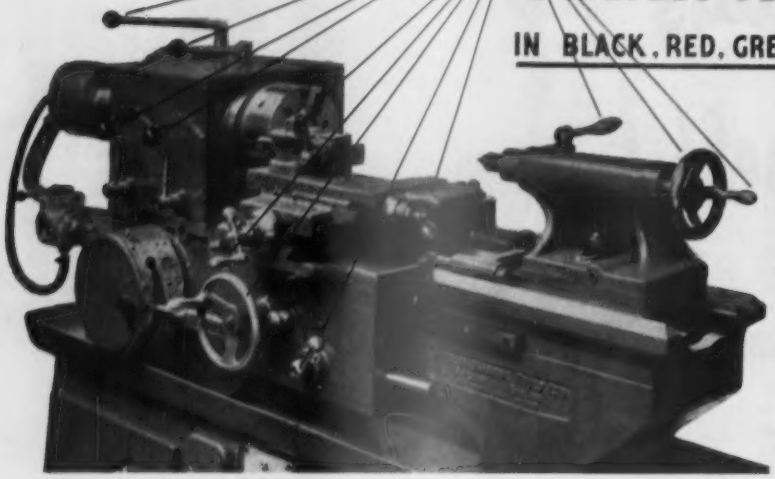

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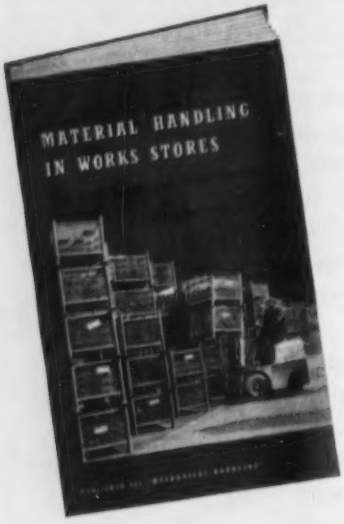

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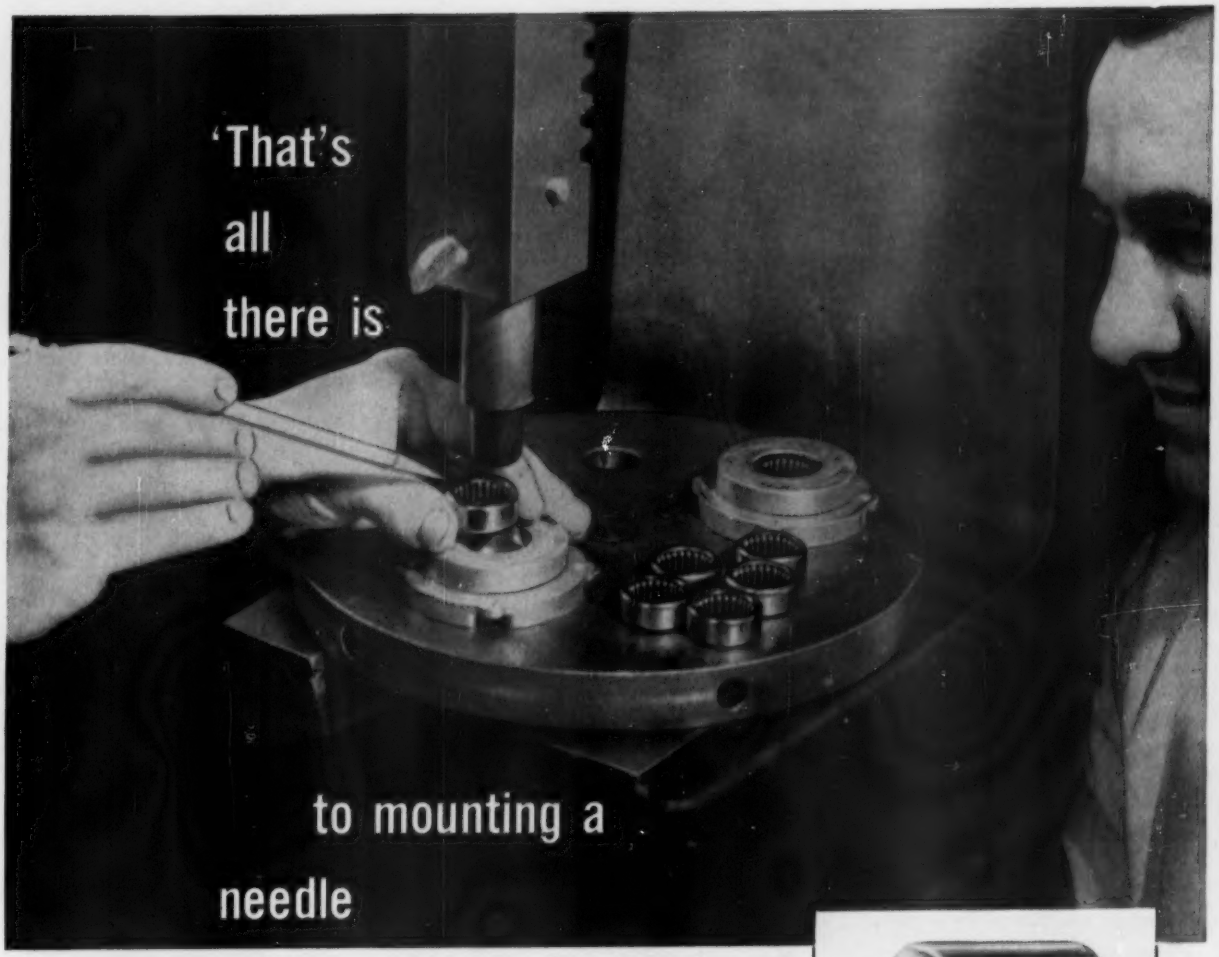

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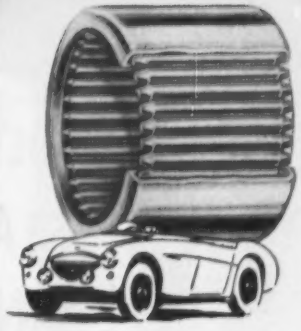

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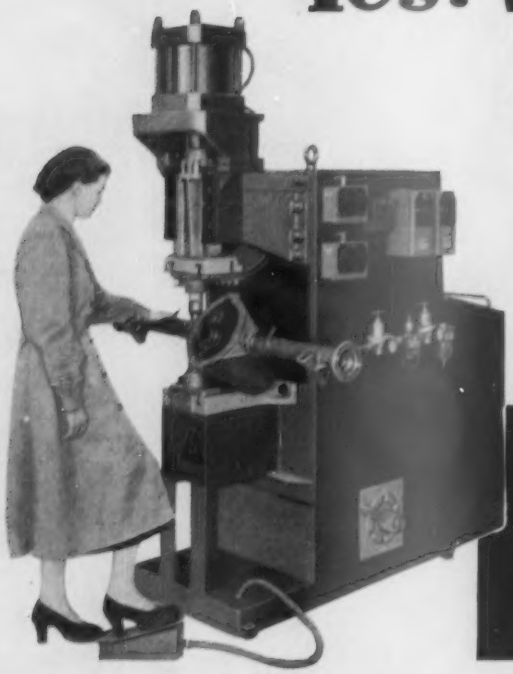

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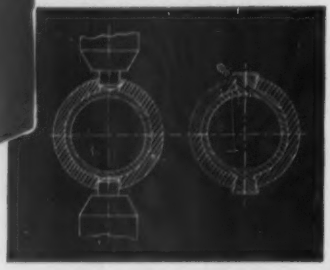

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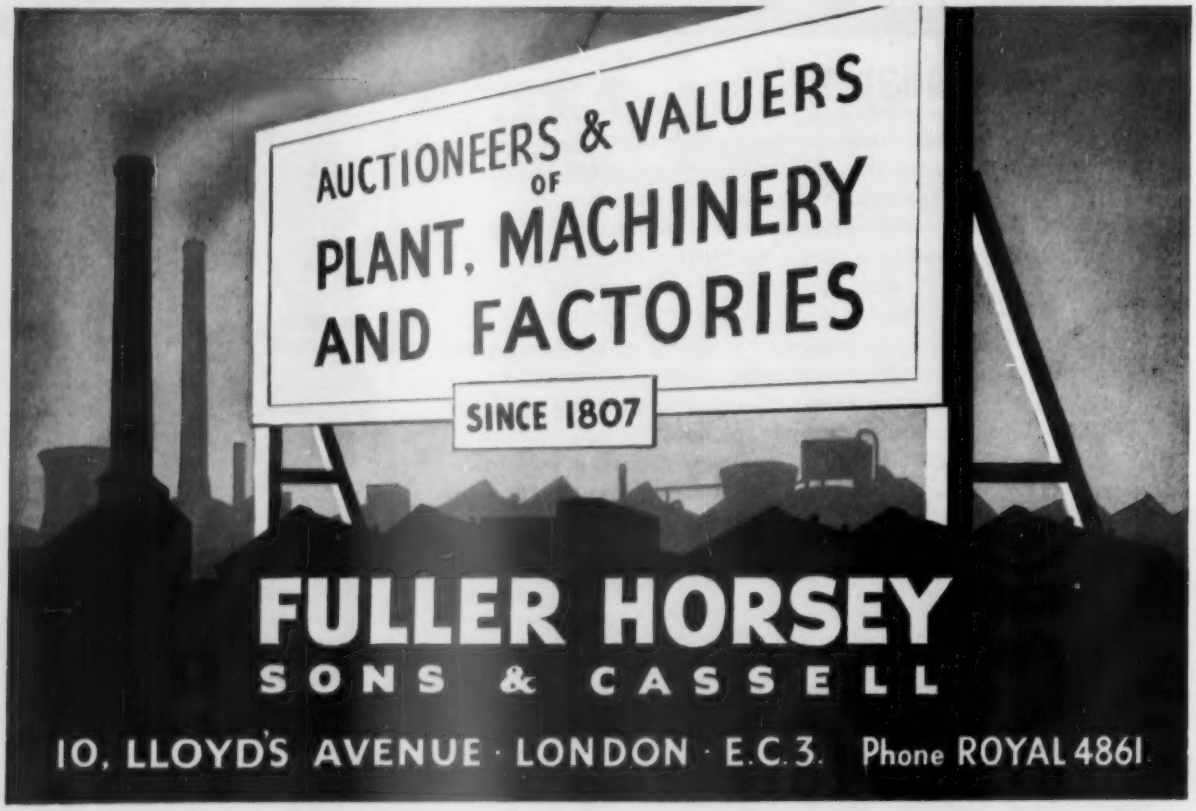

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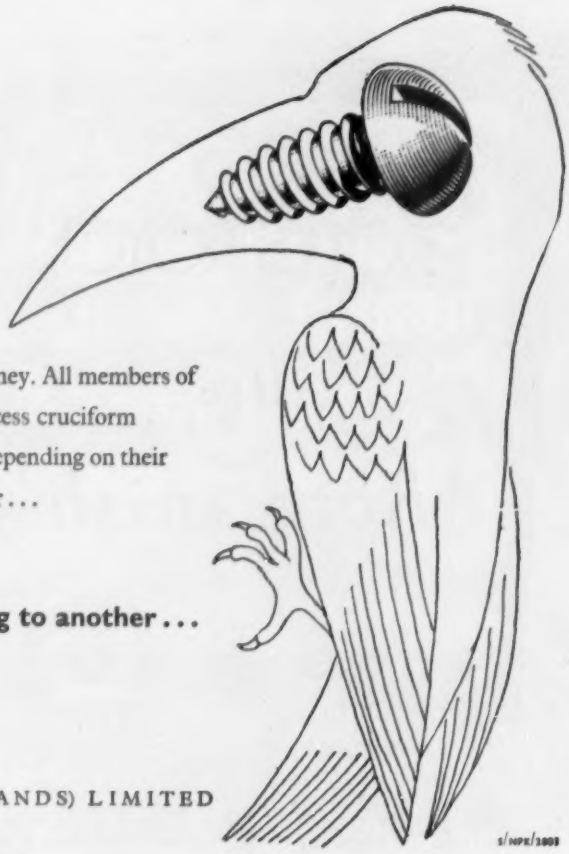

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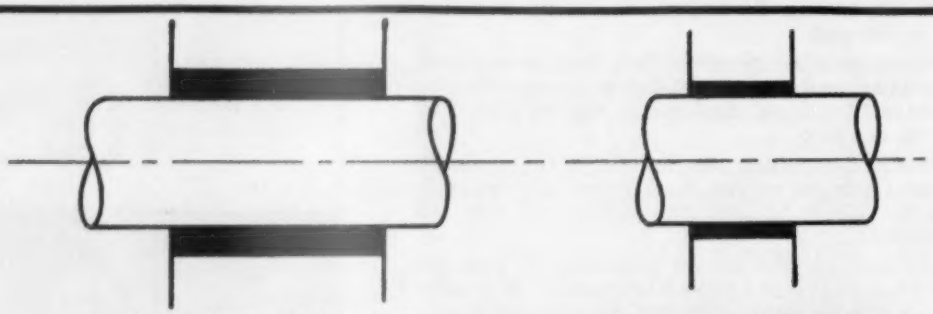

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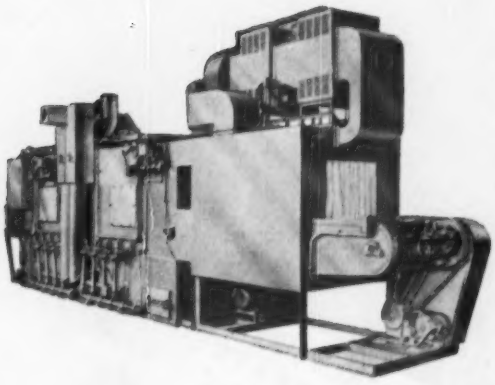

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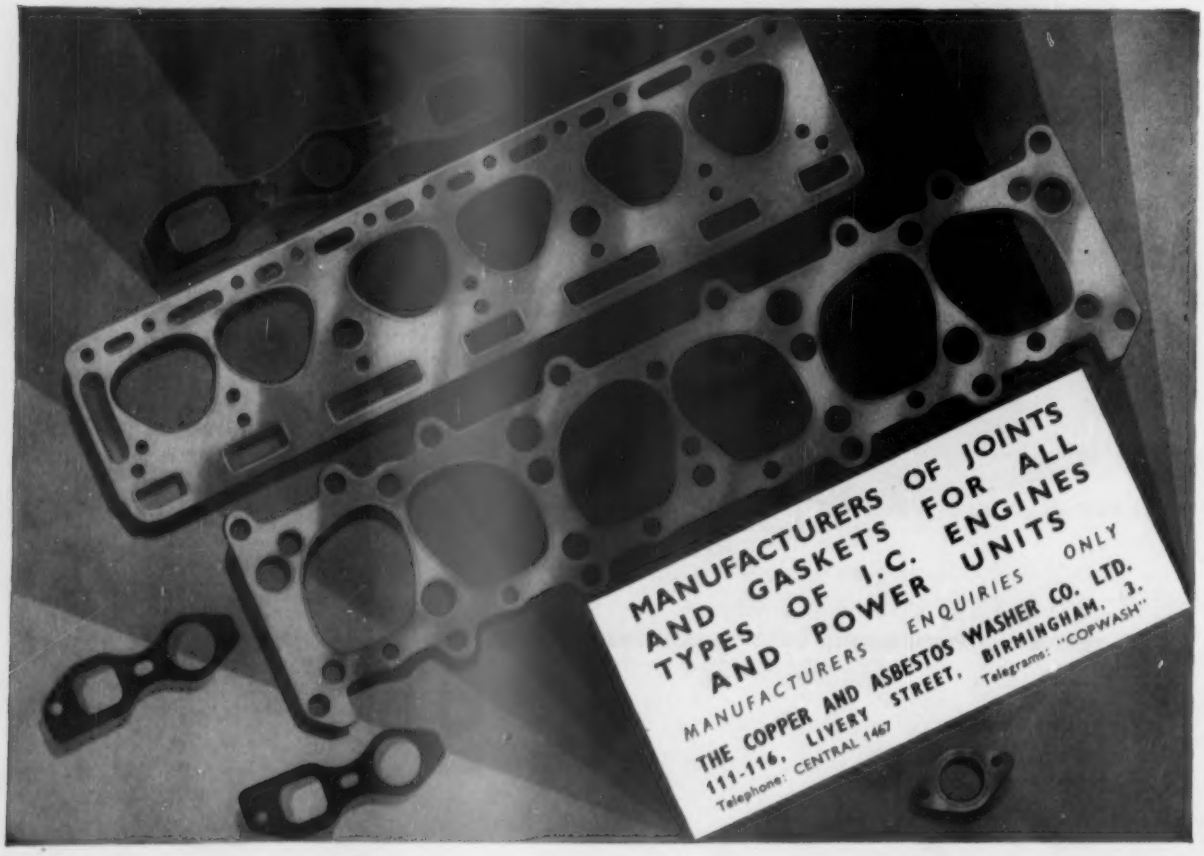
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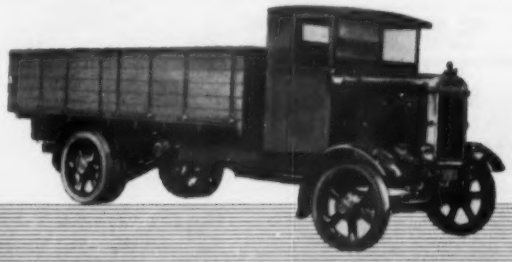

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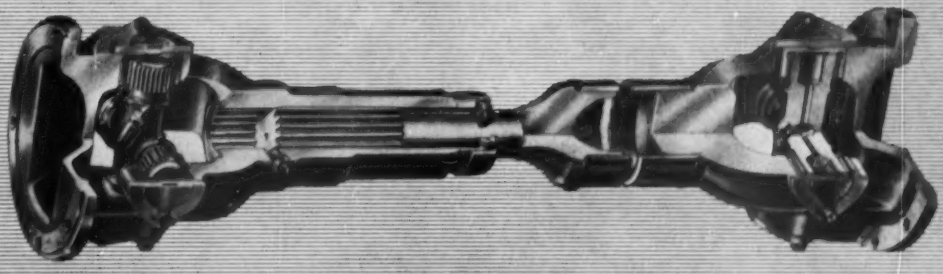

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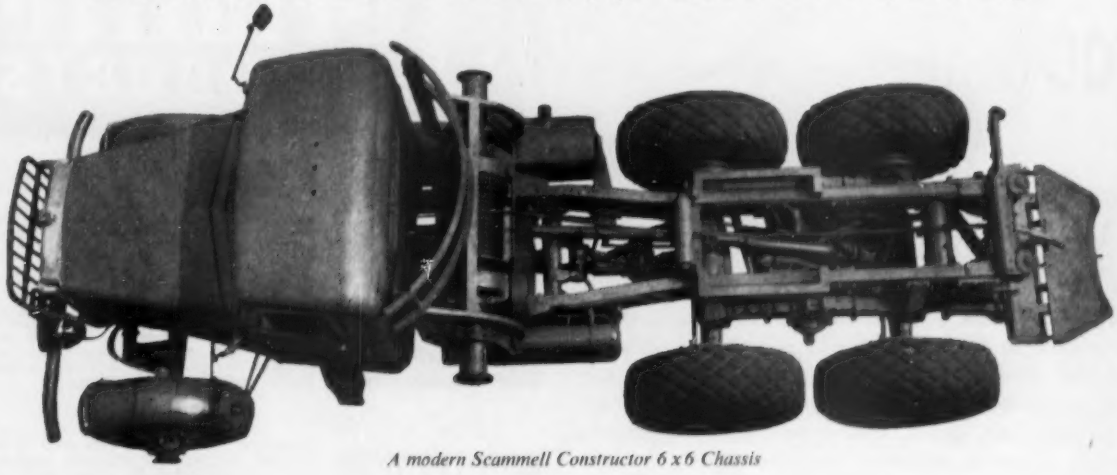

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The Model 16 is one of a wide range of car aerials which have been designed for fitting on the header, valance, mudguard, etc. The Model 16 is fully retractable and is extendable to 5' 0" above the mounting surface. It is capable of providing a high signal pickup with low noise level.

Please send for details of the above and other products in the Aerialite Range.

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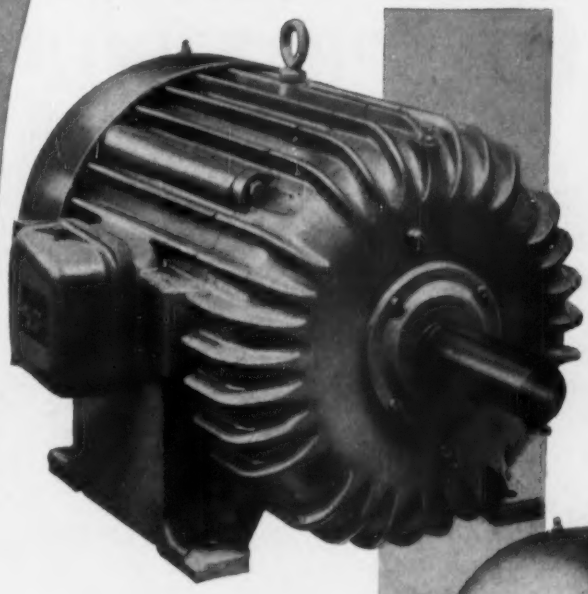

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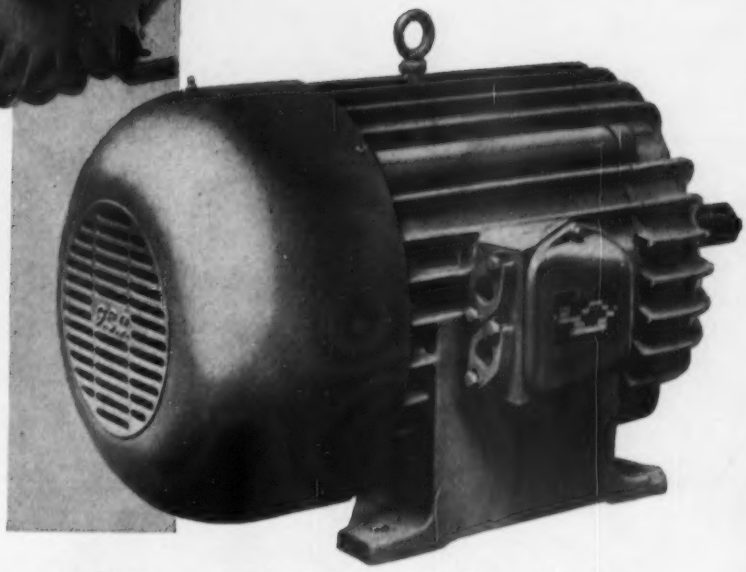

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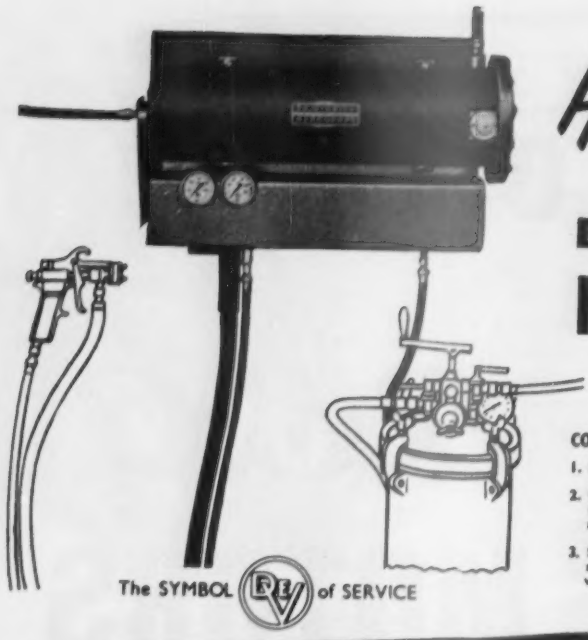

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3. **Smoother flow** — keeps paint at constant temperature and pressure, even when spraying is interrupted.
4. **No sags** — fewer rejects.
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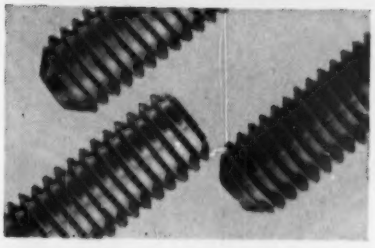

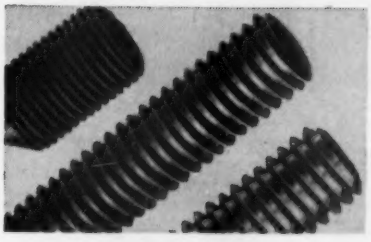

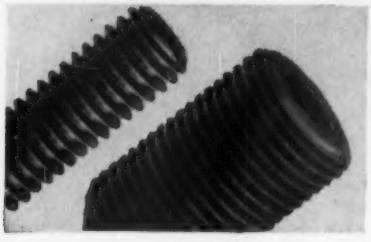

To speed production? Look for easy thread start, the hex socket for speedy, sure drive.

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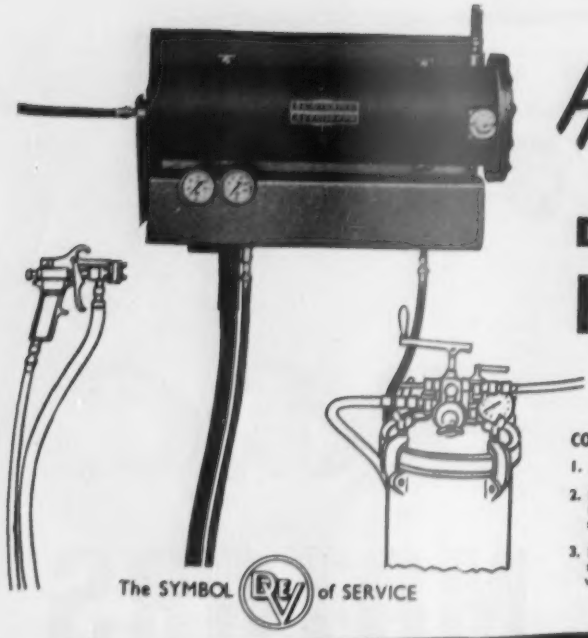

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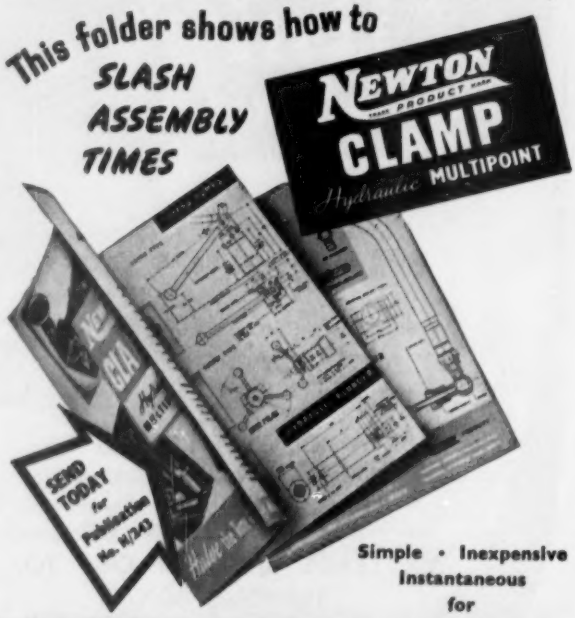

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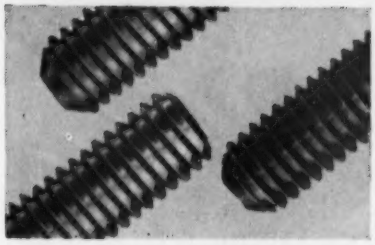

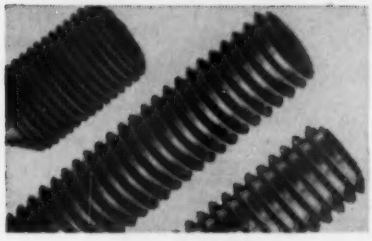

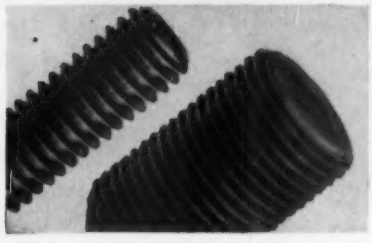

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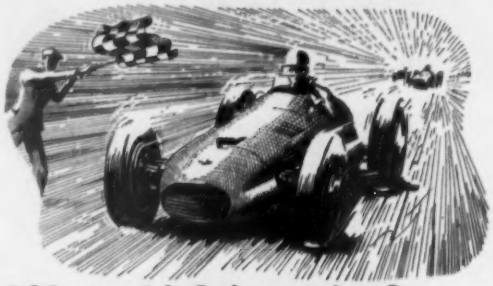

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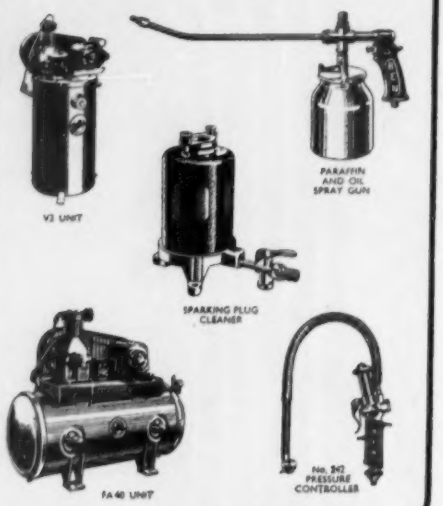

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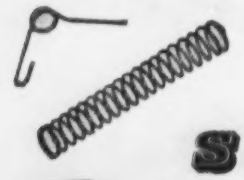

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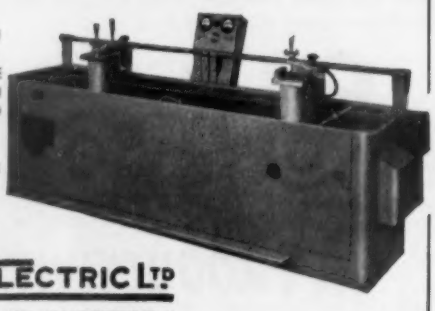

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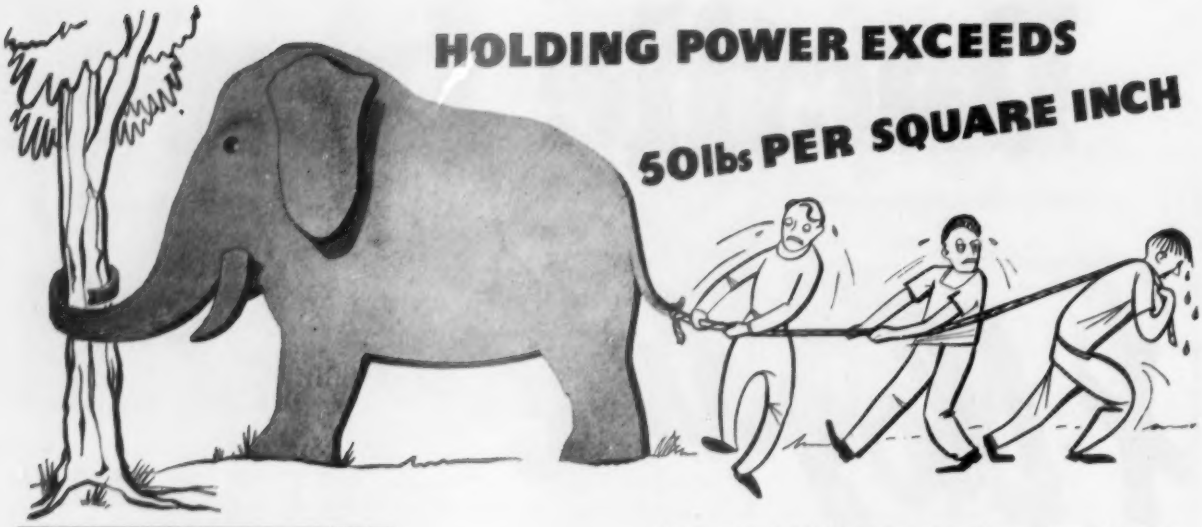

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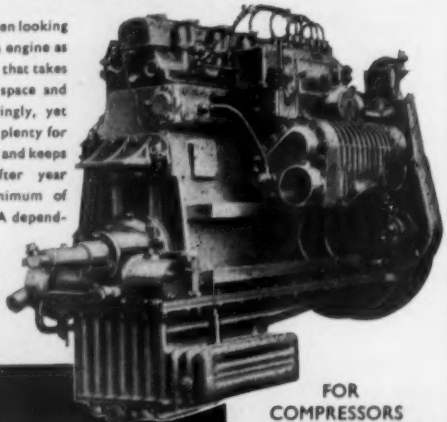

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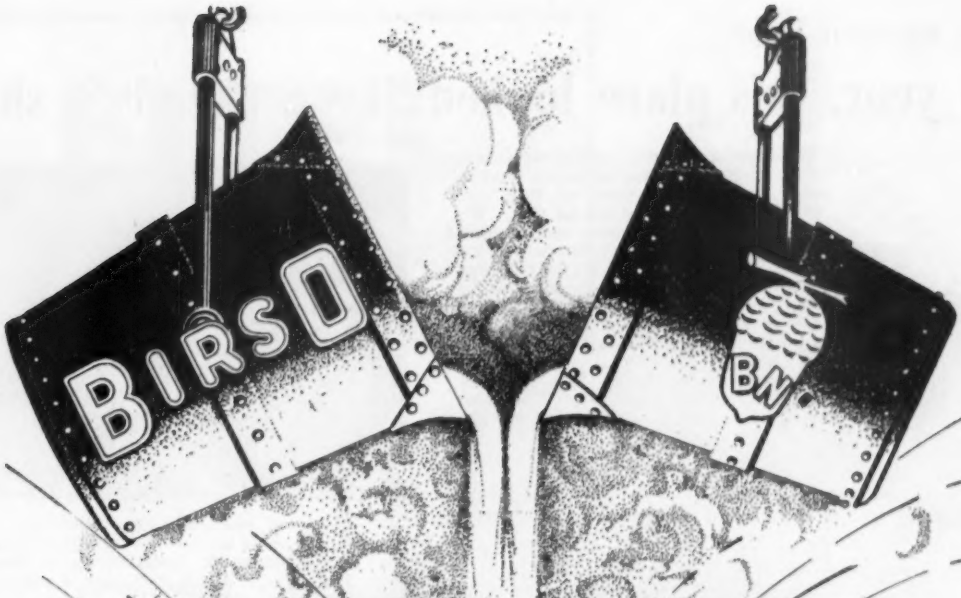

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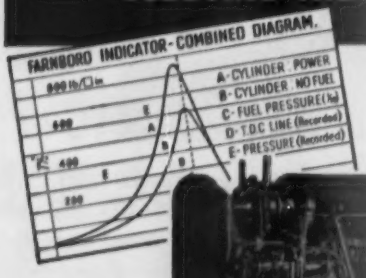

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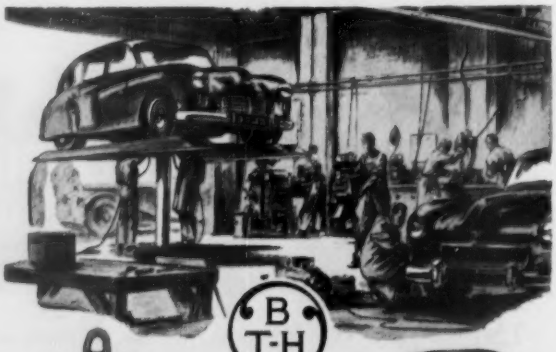

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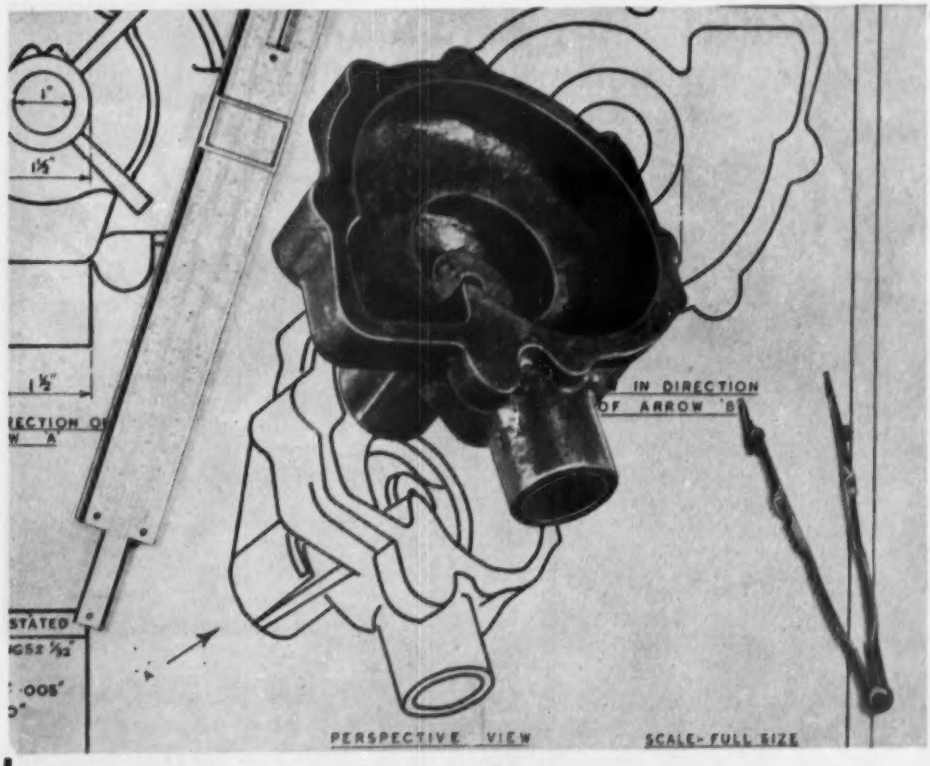

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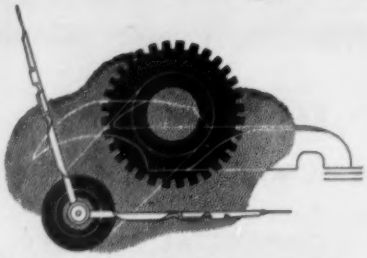

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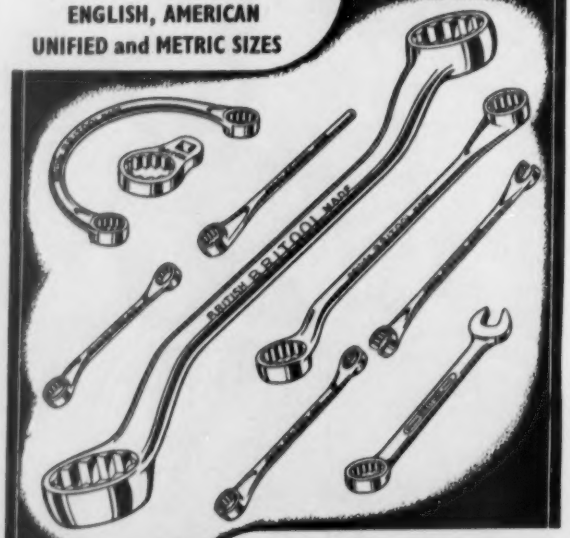

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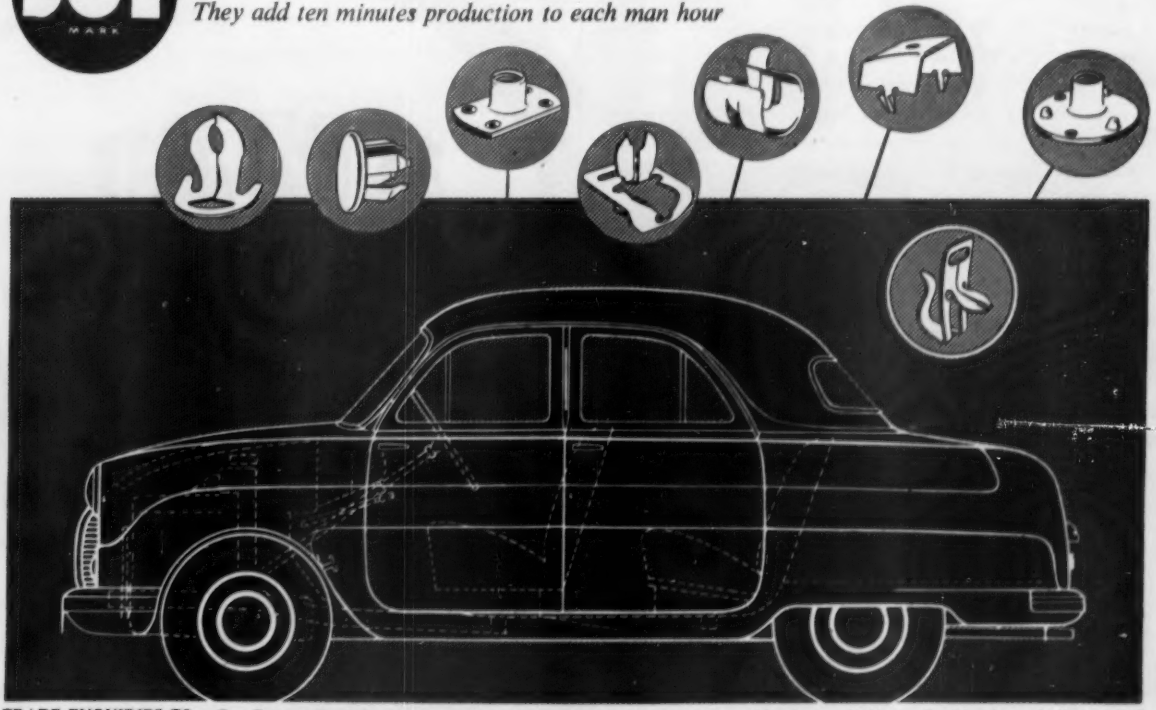

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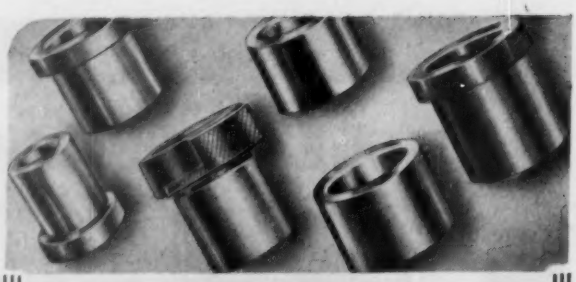

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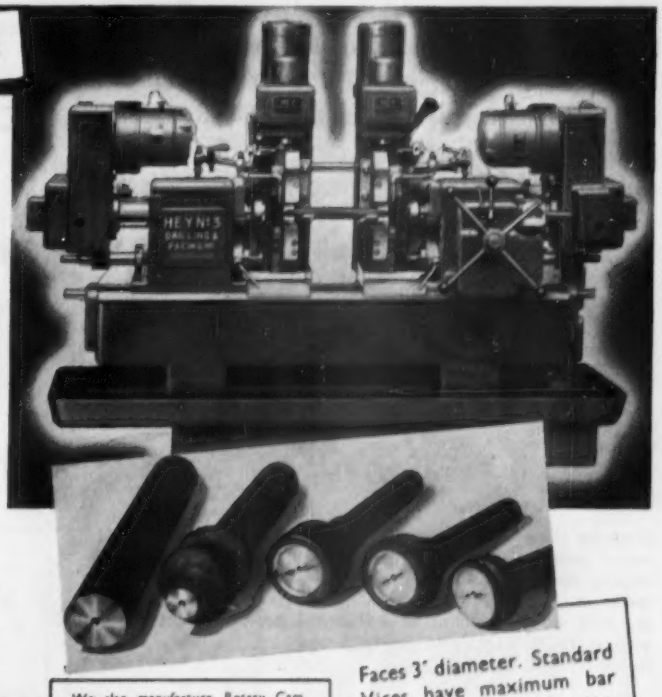

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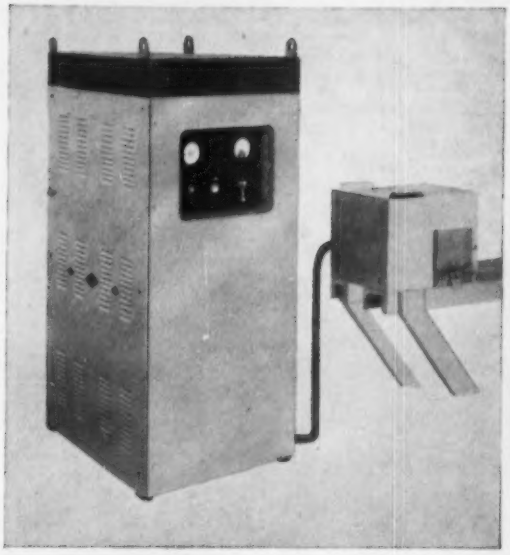

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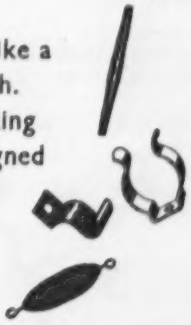

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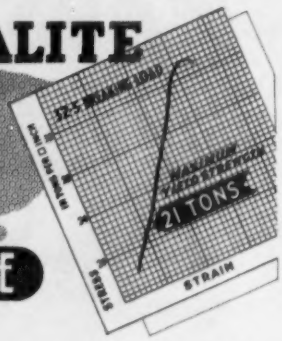

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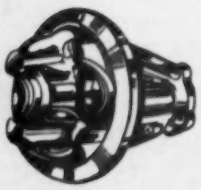

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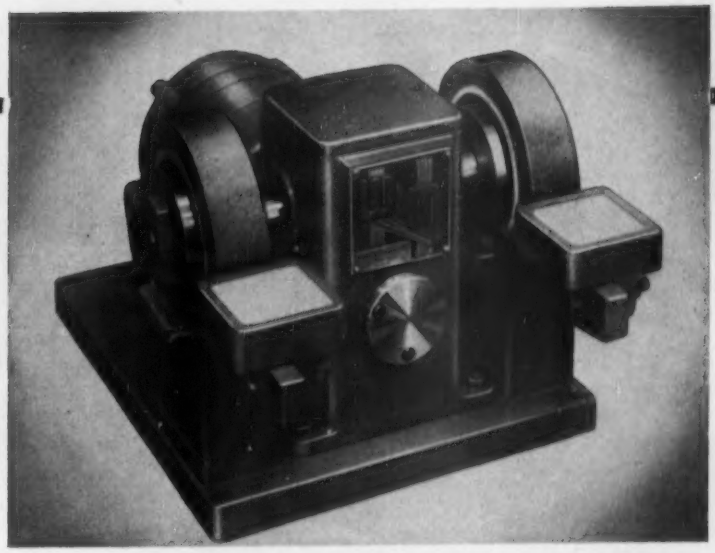

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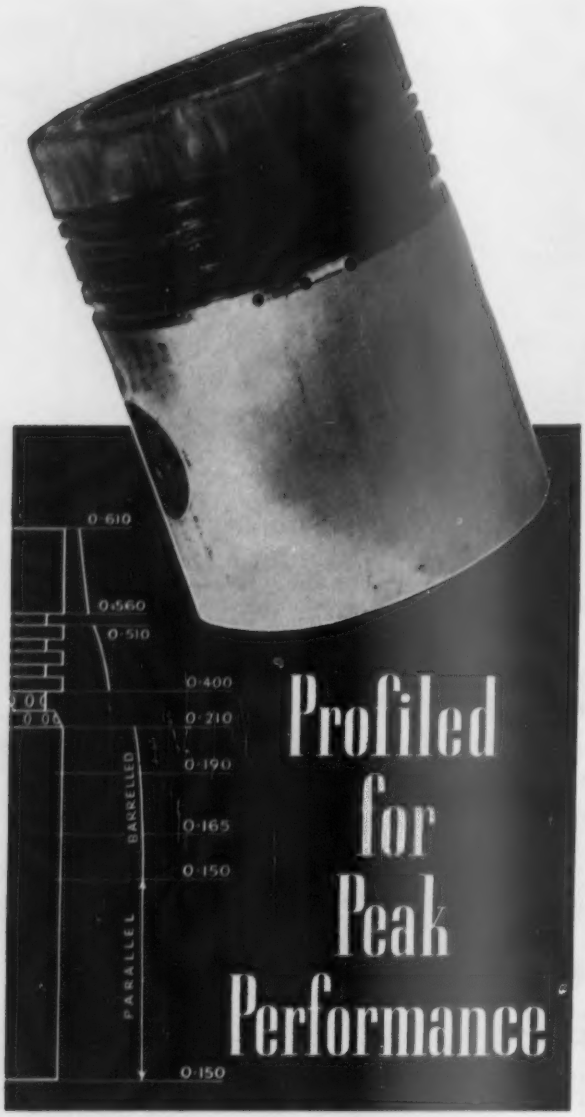

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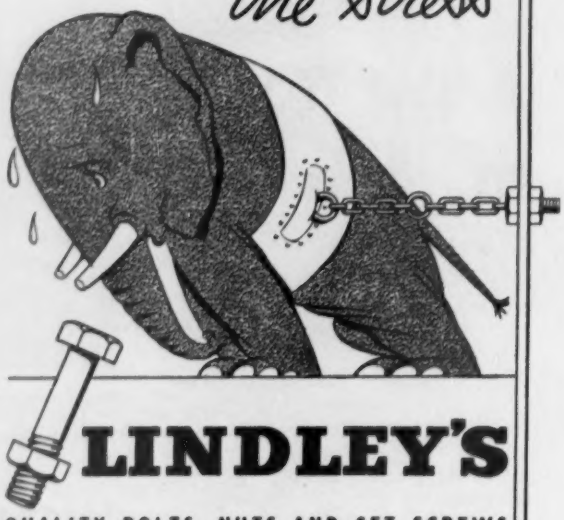

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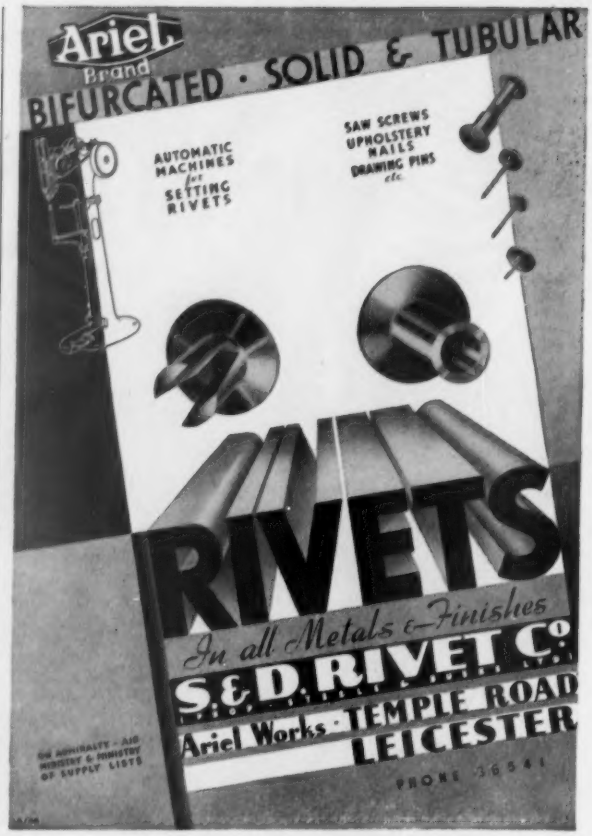

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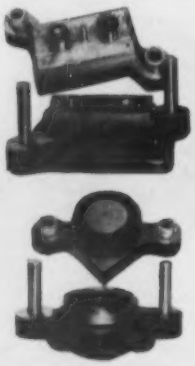

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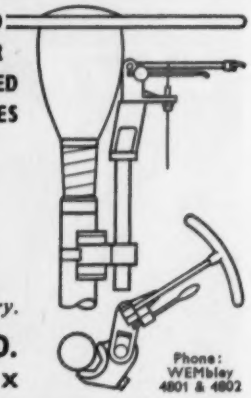

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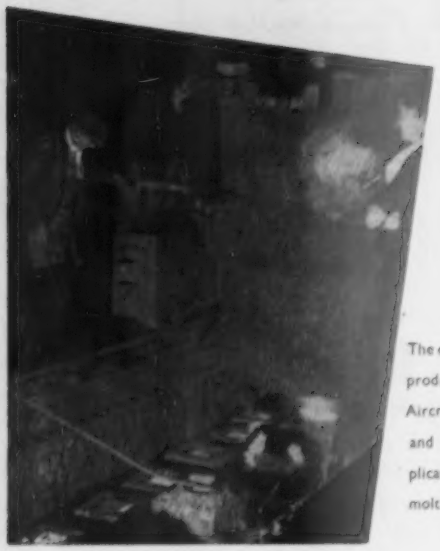

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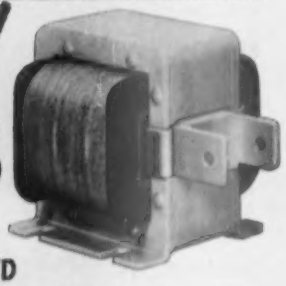

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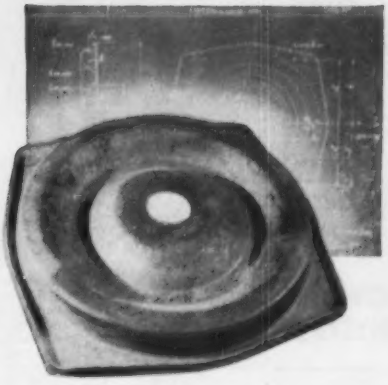

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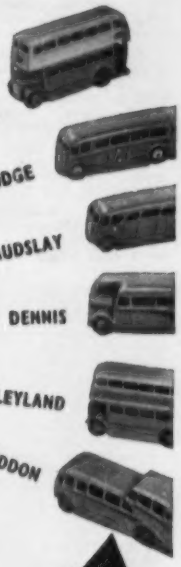

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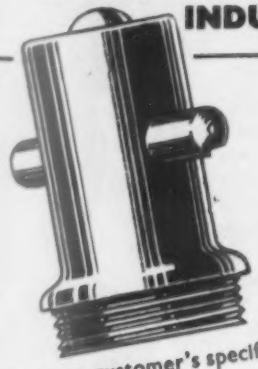

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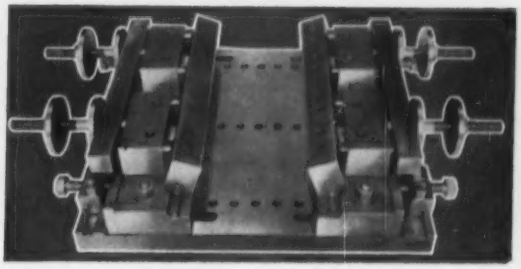

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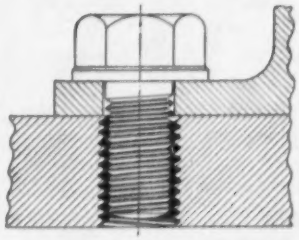

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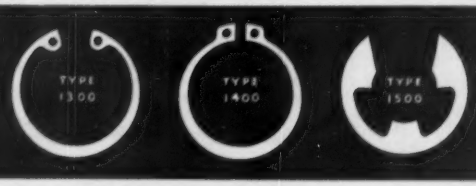

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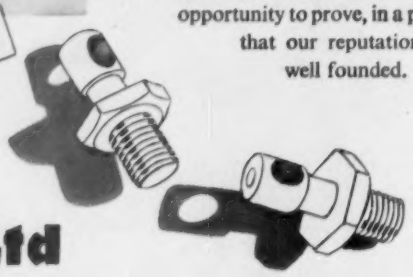

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